United States Army Aviation Logistics School
Fort Eustis, Virginia

APRIL 1994

THIS DOCUMENT HAS BEEN REVIEWED FOR OPSEC CONSIDERATIONS

STUDENT HANDOUT

POWERTRAIN

071-638-04

The proponent for this SH is USAALS

INTRODUCTION

TERMINAL LEARNING OBJECTIVE:

At the completion of this lesson you will:

ACTION: Analyze powertrain system malfunctions.

CONDITIONS: Given TM 55-1520-238-23 and TM 1-1520-238-T series manuals.

STANDARDS: Determine by selecting from a list, the corrective actions for abnormal condition(s), in accordance with TM 1-1520-238-T and TM 55-1520-238-23 series manuals, with a minimum of 70% accuracy.

SAFETY REQUIREMENTS: In addition to the specific safety requirements of this lesson plan, aviation shop and flight line safety standards established in the applicable manuals will be reinforced.

RISK ASSESSMENT LEVEL: Low

WARNING

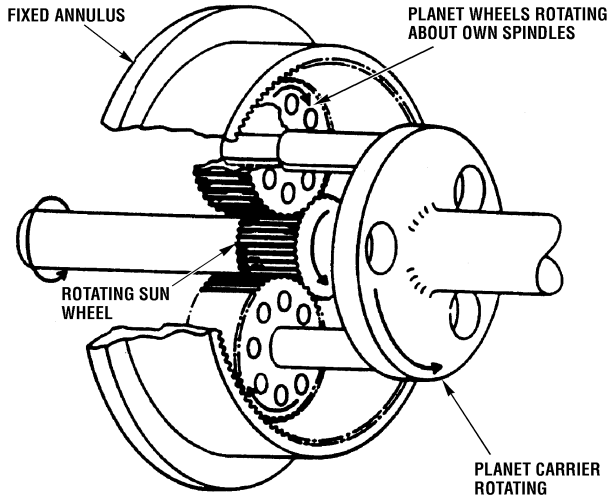
FLIGHT SAFETY PART

Many of the powertrain components are considered flight safety parts. Failure to follow maintenance instructions may result in serious injury or death of crew members and/or serious damage to the helicopter.

ENVIRONMENTAL CONSIDERATIONS: Dispose of all unusable or unwanted lubricants and chemicals in accordance with all federal, state, local, and unit SOP regulations and requirements.

071-

PLANETARY GEAR TRAIN



Cutaway isometric of mode of operation of a simple planetary gear train with a fixed or locked annulus.

06-94-07

NOTES

A. Gear terms

1. To better understand the AH-64A powertrain, a knowledge of the basic terms used in gear design and application is essential.

2. The following list contains definitions of terms used in describing AH-64A powertrain components.

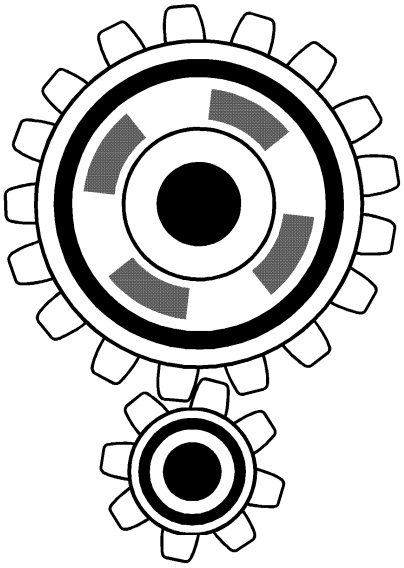
a. Planetary gear train - An assembly of meshed gears consisting of a central gear (sun gear), a coaxial internal or ring gear, and one or more intermediate pinions (planet gears) supported on a revolving carrier.

b. Sun gear - The gear on the central axis of a planetary gear train, about which a pinion rotates.

071-

PINION GEAR

06-94-08



PINION

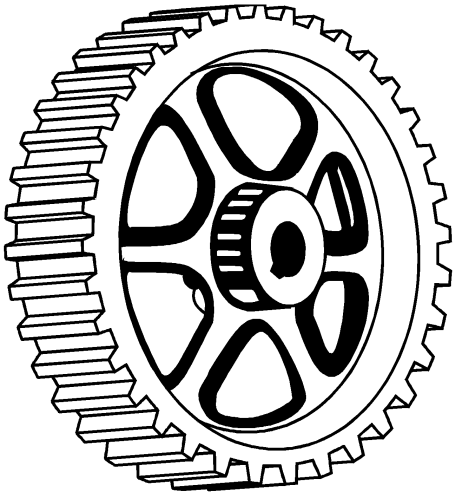
NOTES

c. Pinion - The smaller of a pair of gear wheels or the smallest wheel of a gear train.

071-

SPUR GEAR

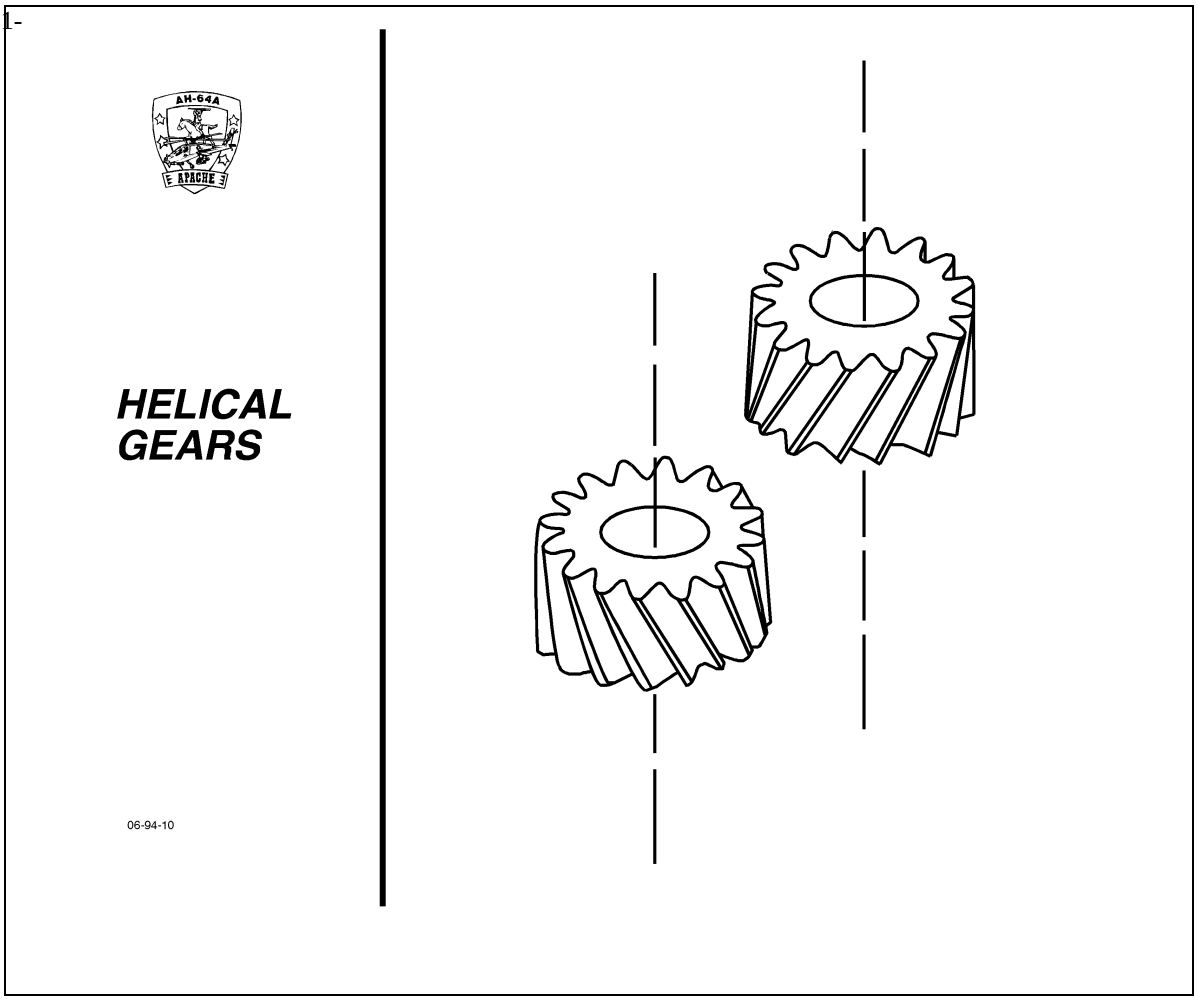
06-94-09



NOTES

d. Spur gear - A toothed wheel with radial teeth parallel to the axis.

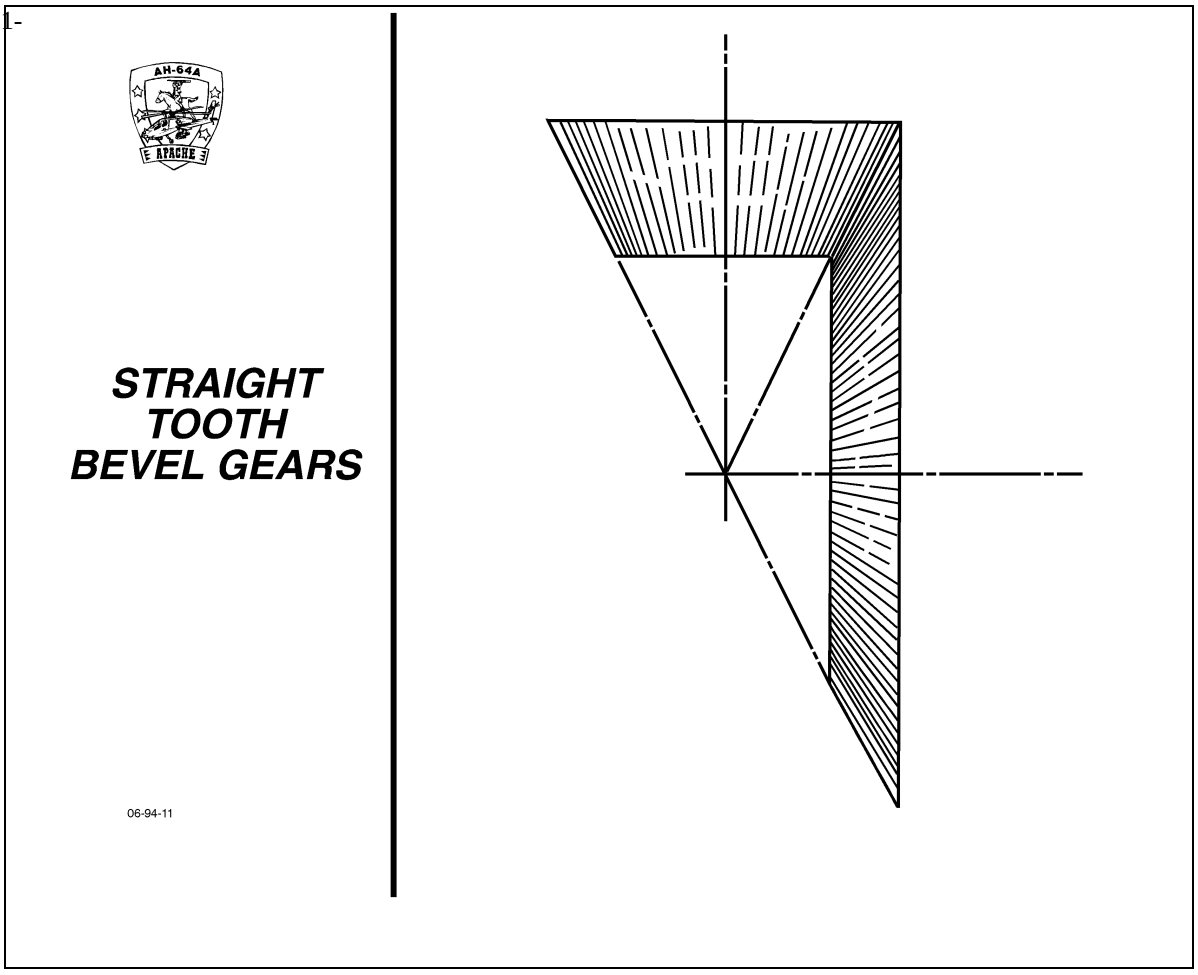
071-



NOTES

e. Helical gear - Gear wheels running on parallel axes, with teeth twisted oblique to the gear axis.

071-

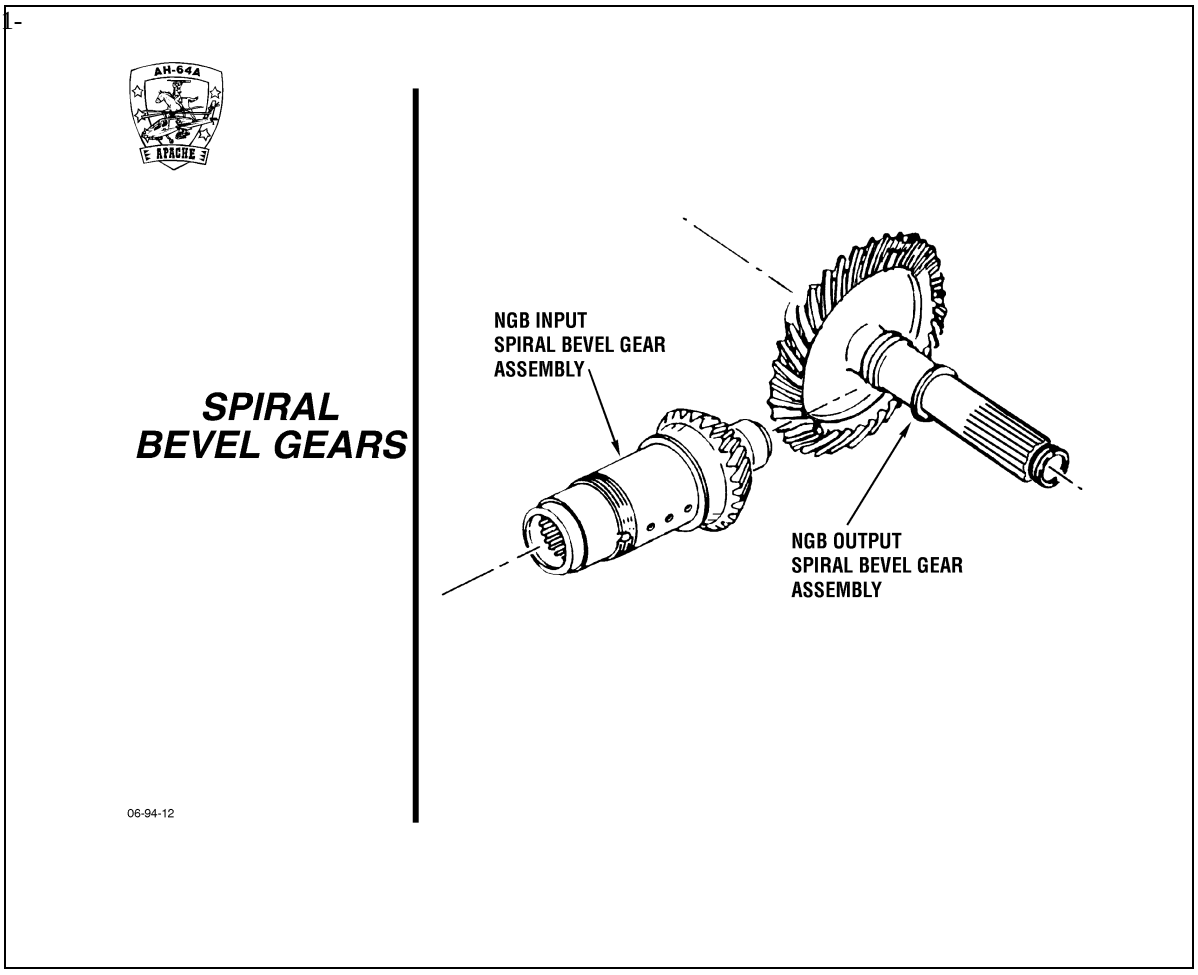


NOTES

f. Bevel gear - One of a pair of gears used to connect two shafts whose axes intersect.

(1) Straight tooth bevel gears - If all the elements of the tooth surfaces intersect at the intersection of the shaft axes, the bevel gears are called straight tooth bevel gears.

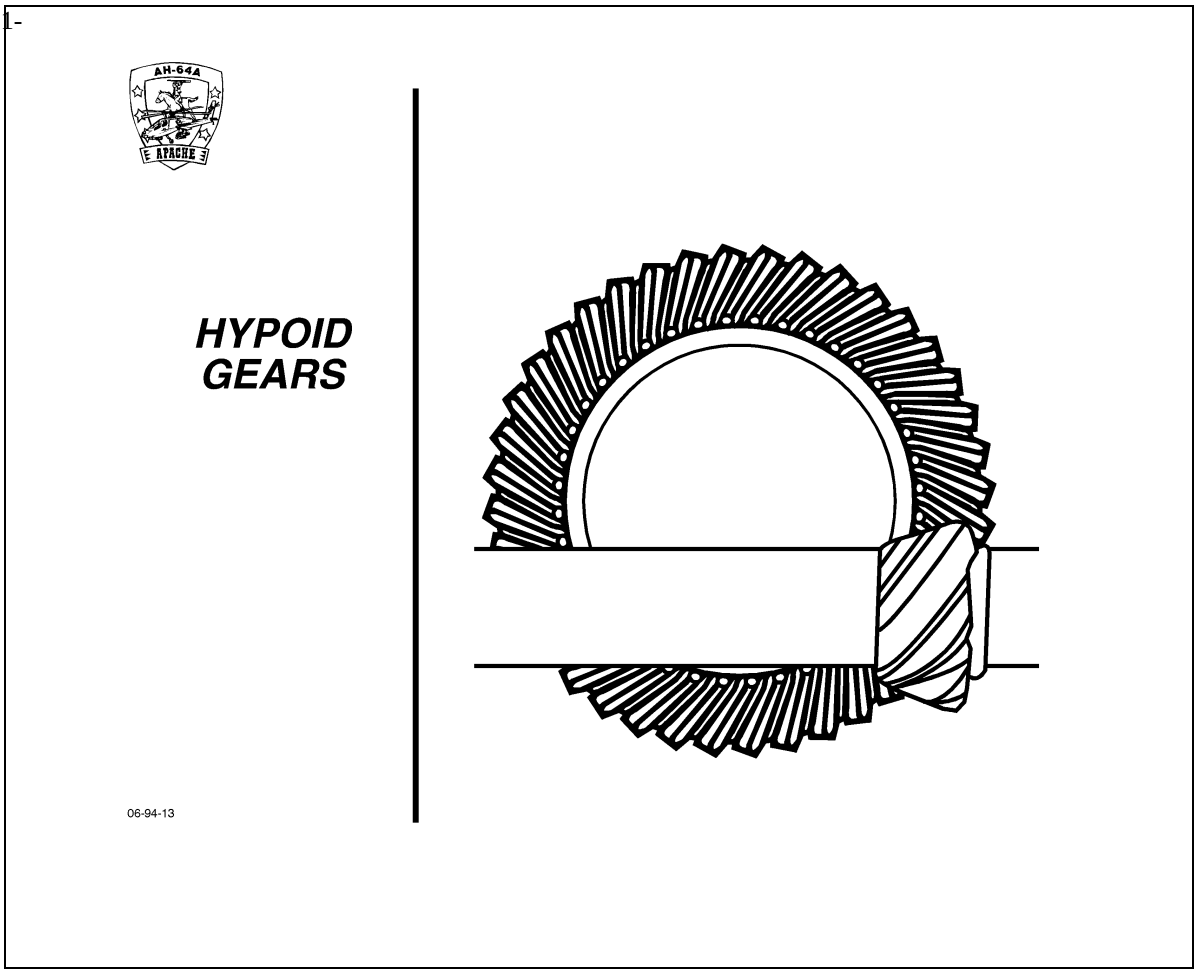
071-


AH-64A
APACHE
SPIRAL
BEVEL GEARS
NGB INPUT
SPIRAL BEVEL GEAR
ASSEMBLY
NGB OUTPUT
SPIRAL BEVEL GEAR
ASSEMBLY
06-94-12

NOTES

(2) Spiral bevel gears - If the tooth elements are curved, the bevel gears are called spiral bevel gears.

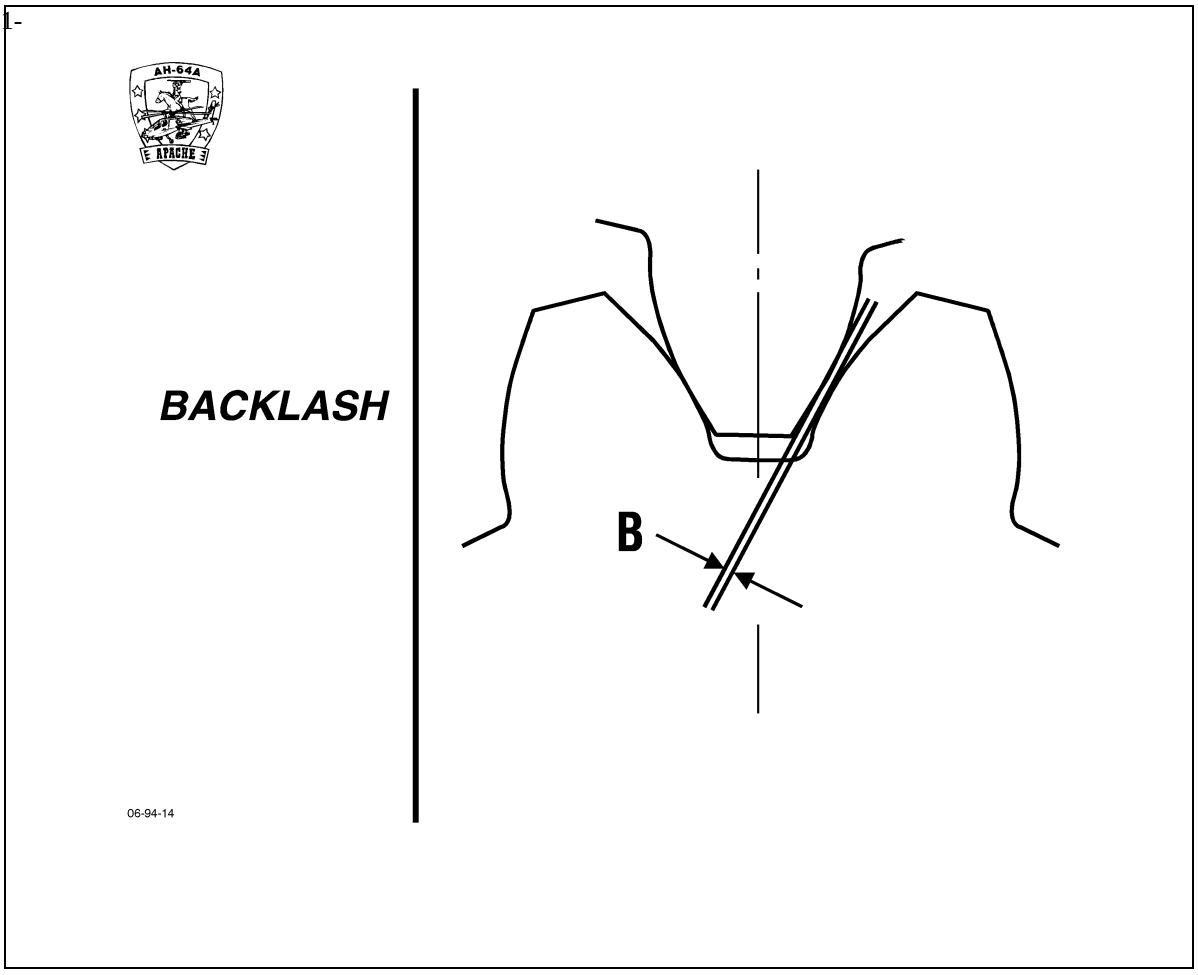
071-



NOTES

(3) Hypoid gear - Bevel gears that connect non-parallel, non-intersecting shafts (usually at a right angle) are called hypoid gears.

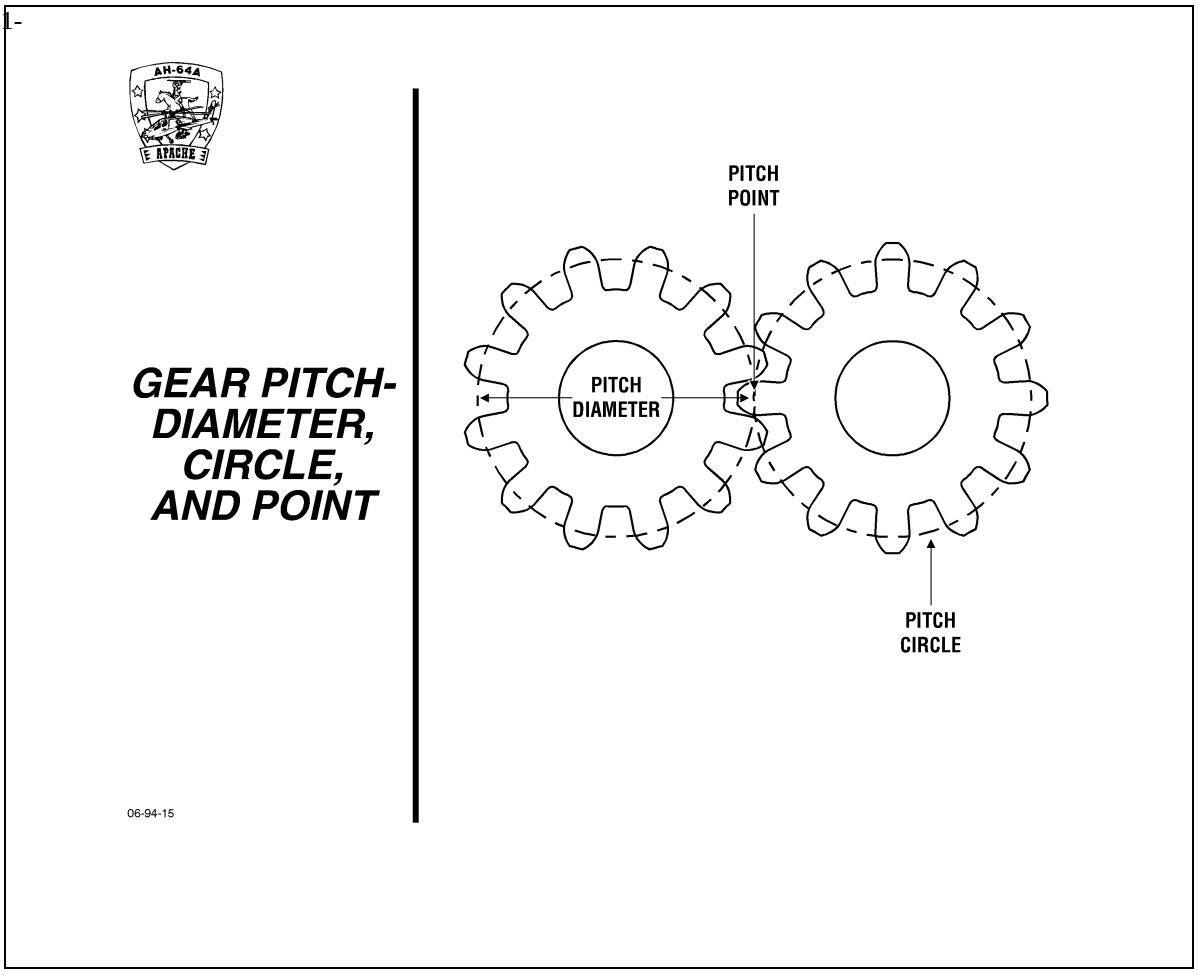
071-



NOTES

g. Backlash - The shortest distance between non-driving tooth surfaces of adjacent teeth in mating gears.

071-


AH-64A
APACHE
GEAR PITCH-
DIAMETER,
CIRCLE,
AND POINT
06-94-15
PITCH
POINT
PITCH
DIAMETER
PITCH
CIRCLE

NOTES

h. Gear terms

(1) Pitch diameter - The diameter of the pitch circle of a gear.

(2) Pitch circle - A circle the radius of which is equal to the distance from the gear axis to the pitch point.

(3) Pitch point - The point of tangency of the pitch circles of mating gears.

B. Efficiency of gearing and power transmission

1. The efficiency of power transmission by the use of spur and bevel gears is very high.

2. The loss of power for each set of spur gears in a train, where an oil bath is provided and the gears are manufactured with modern machinery, does not ordinarily exceed one-half of one percent.

3. Where bevel gears are mounted under the same conditions with anti-friction thrust bearings, efficiency can easily exceed 99 percent.

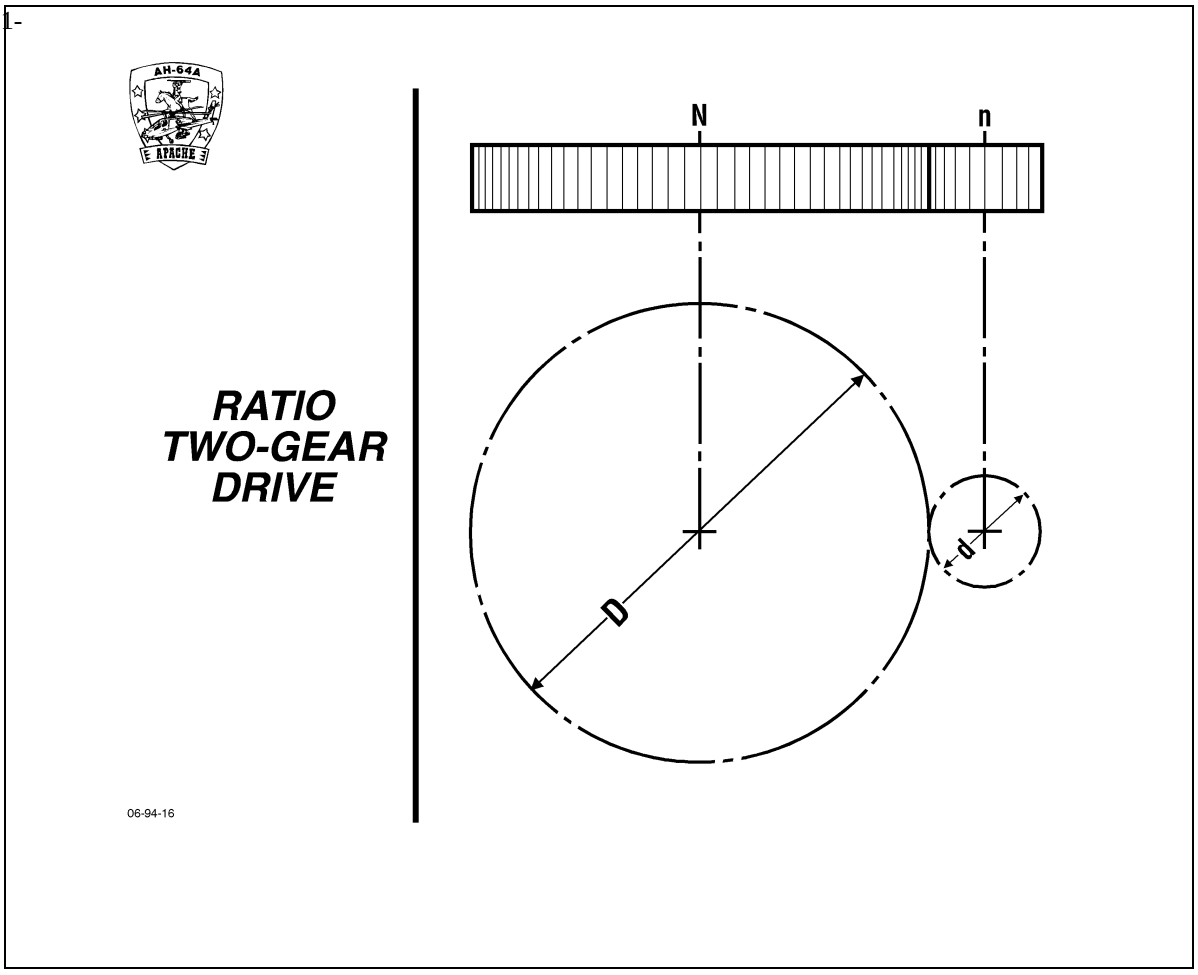
4. Efficiency in a geartrain is important because:

a. More power is transferred to the using components.

b. Energy requirements are less.

c. Friction is reduced, consequently heat and wear are reduced.

071-



NOTES

5. Ratio - Two-gear drive

a. In referring to the ratio of gearing, it is customary to give the ratio of the number of gear teeth to the number of pinion teeth instead of reversing this order.

b. If the ratio is 2 or "2 to 1," this usually means that the smaller gear or pinion makes two revolutions to one revolution of the larger gear, or that the larger gear has twice as many teeth as the smaller gear or pinion.

c. RULE: To find the ratio of gearing, divide the number of teeth on the larger gear by the number of teeth on the smaller gear (or pinion).

d. NOTE: The same result will be obtained if the pitch diameters are used instead of the number of teeth.

$$\text{Ratio} = \frac{N}{n} \qquad \text{or} \qquad \text{Ratio} = \frac{D}{d}$$

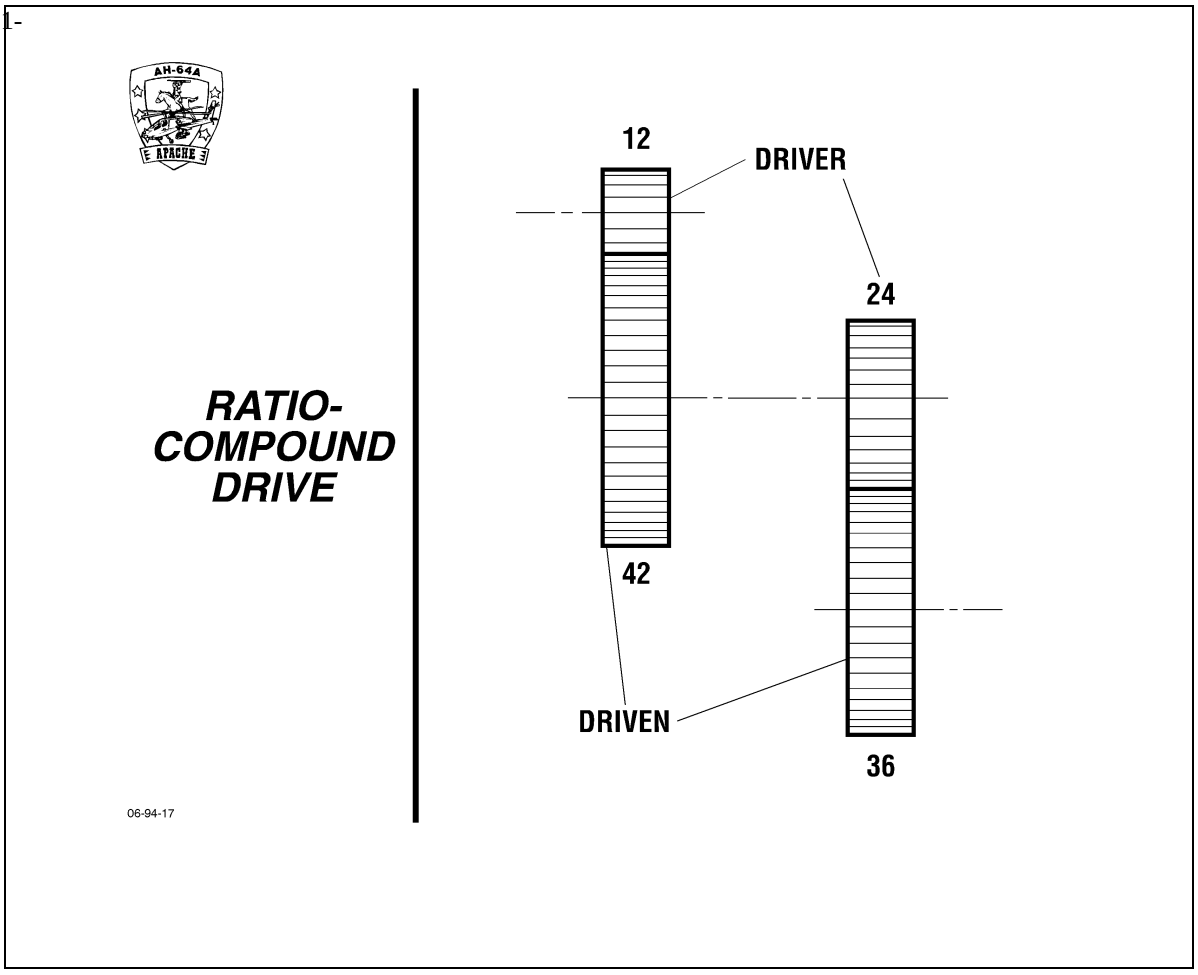
e. EXAMPLE 1: A gear has 45 teeth and its mating pinion 18 teeth; then

$$\text{Ratio} = \frac{45}{18} = 2.5 \text{ or } 2.5 \text{ to } 1$$

f. EXAMPLE 2: A gear has a pitch diameter of 15 inches and the mating pinion a pitch diameter of 6 inches; then

$$\text{Ratio} = \frac{15}{6} = 2.5 \text{ or } 2.5 \text{ to } 1$$

071-


AH-64A
APACHE
RATIO-
COMPOUND
DRIVE
06-94-17
12
DRIVER
24
42
DRIVEN
36

NOTES

6. Ratio - Compound drive

a. RULE: To find the ratio of a compound train of gears, divide the product of the number of teeth on the driven gears by the product of the number of teeth on the driving gears (pitch diameters may be substituted for the number of teeth).

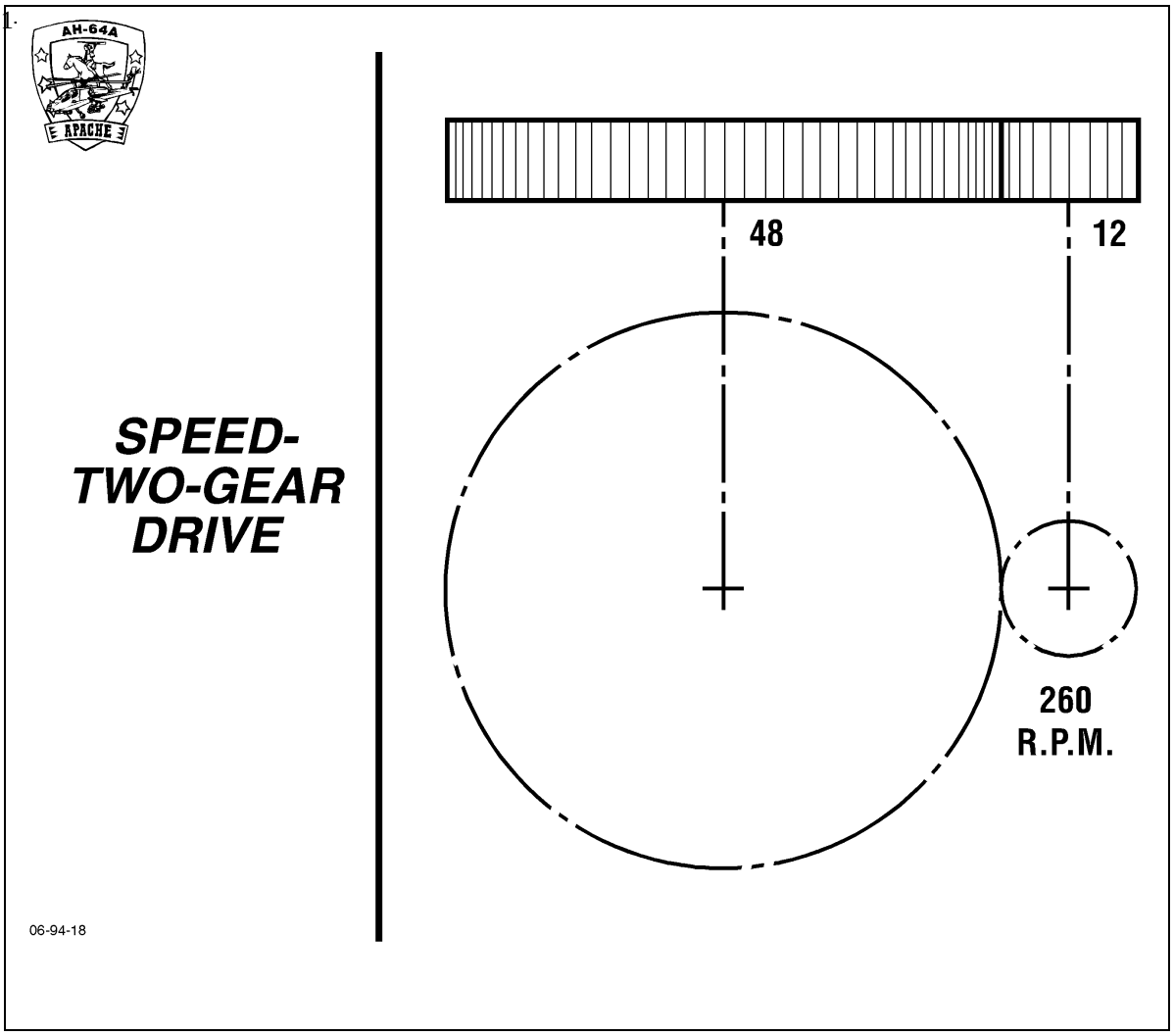
$$\text{Ratio} = \frac{\text{Product of driven gear teeth or sizes}}{\text{Product of driving gear teeth or sizes}}$$

b. EXAMPLE: Find the ratio of the four-gear train shown in the diagram.

$$\text{Ratio} = \frac{42 \times 36}{12 \times 24} = 5.25$$

c. The first driving gear (or pinion) makes 5.25 revolutions to one revolution of the last driven gear.

071.



NOTES

C. Gearing speeds

1. Speed of a driven gear - Two-gear drive

a. RULE 1: Multiply the number of teeth on the driving gear by its number of revolutions per minute and divide the product by the number of teeth on the driven gear.

b. EXAMPLE 1: If the driving pinion has 12 teeth and makes 260 revolutions per minute, and the driven gear has 48 teeth; then

$$\text{Speed of driven gear} = \frac{12 \times 260}{48} = 65 \text{ RPM}$$

c. EXAMPLE 2: Using example 1, the opposite gear is the driver. To find the speed of the pinion, apply Rule 1.

$$\text{Speed of driven pinion} = \frac{48 \times 65}{12} = 260 \text{ RPM}$$

d. RULE 2: Divide the speed of the driver in revolutions per minute by the gear ratio (or multiply by the inverse ratio).

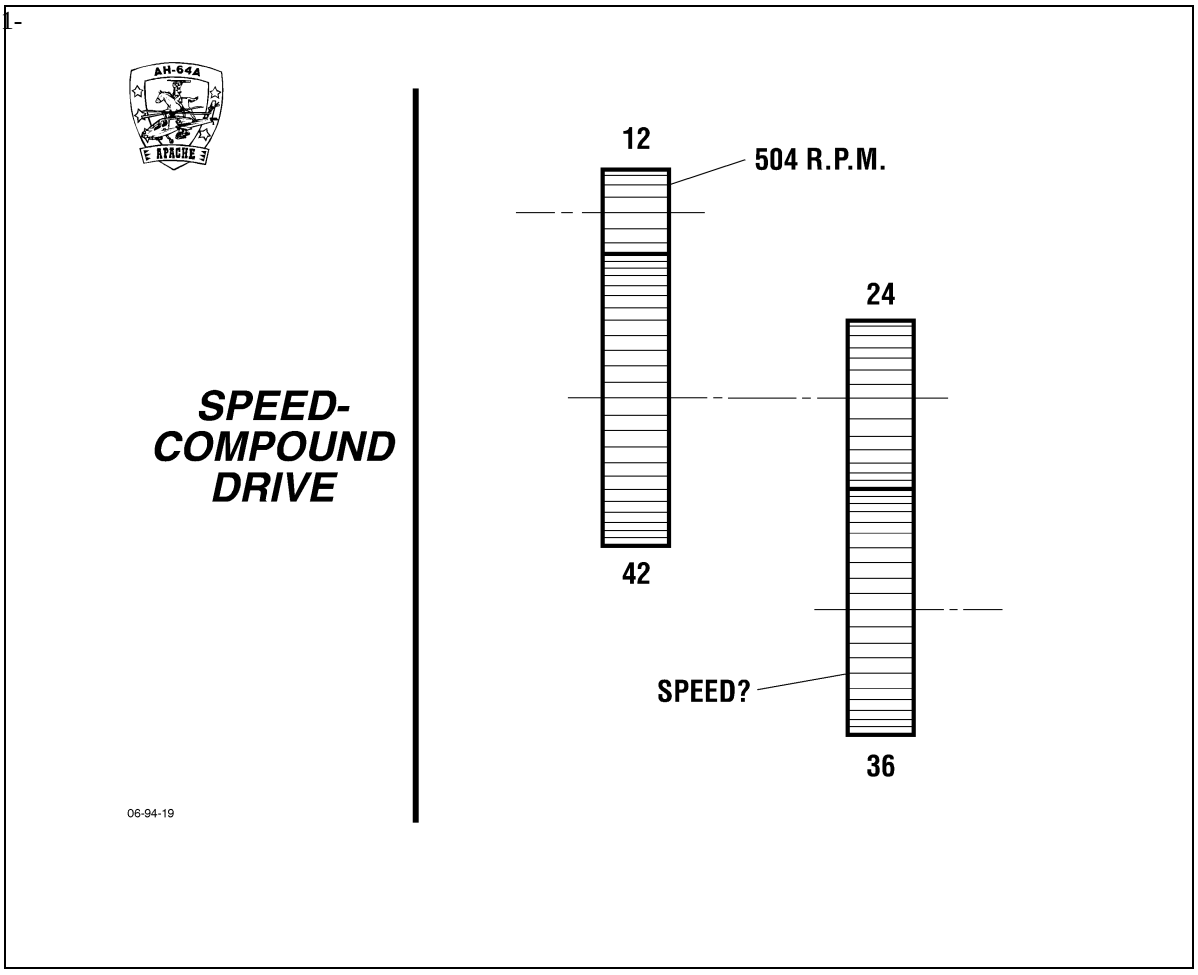
e. EXAMPLE 3: In example 1, the ratio equals 48) 12 = 4; hence

$$\text{Speed of driven gear} = \frac{260}{4} = 65 \text{ RPM}$$

f. EXAMPLE 4: In Example 1, the inverse ratio equals 12) 48 = 0.25.

$$\text{Speed of driven gear} = 260 \times 0.25 = 65 \text{ RPM}$$

071-


AH-64A
APACHE
SPEED-
COMPOUND
DRIVE
06-94-19
12
504 R.P.M.
24
42
SPEED?
36

NOTES

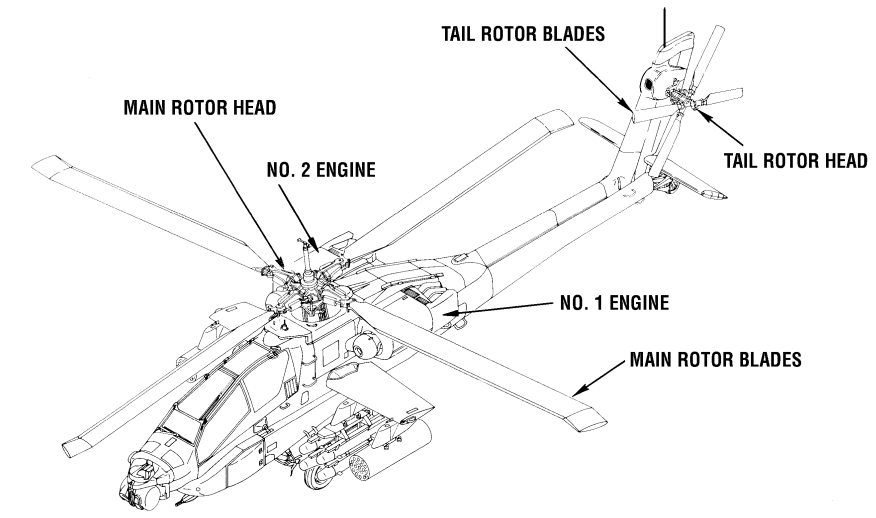
2. Speed of a driven gear - Compound drive

   a. RULE: Multiply the number of revolutions per minute of the driving gear by a fraction, the numerator of which consists of the product of the number of teeth in each of the driving gears, and the denominator of which consists of the product of the number of teeth in each of the driven gears.

   b. EXAMPLE: First driving gear makes 504 revolutions per minute and has twelve teeth, and second driving gear has 24 teeth; first driven gear has 42 teeth, and second or last driven gear, 36 teeth; then

$$\text{Speed of last driven gear} = 504 \times \frac{12 \times 24}{42 \times 36} = 96 \text{ RPM}$$

AH-64A POWERTRAIN SYSTEM



NOTES

D. Powertrain system

1. The powertrain changes the angle of drive and converts the output RPM of the engines into usable power to drive the main rotor system, tail rotor system, and gear driven accessories.

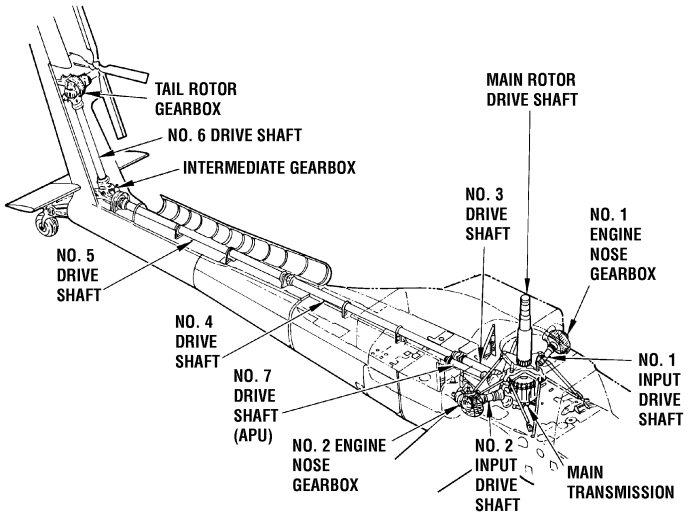
2. When the engines are not operating, the drive system uses power from the auxiliary power unit (APU) to drive aircraft accessories.

3. The powertrain system can be operated with either engine.

4. Operating conditions of the transmission and nose gearboxes are monitored by the fault detection and location system (FD/LS).

5. Under emergency conditions, the main transmission, nose gearboxes (NGBs), intermediate gearbox (IGB), and tail rotor gearbox (TRGB) will operate for a minimum of 30 minutes after loss of lubrication.

POWERTRAIN SYSTEM COMPONENTS



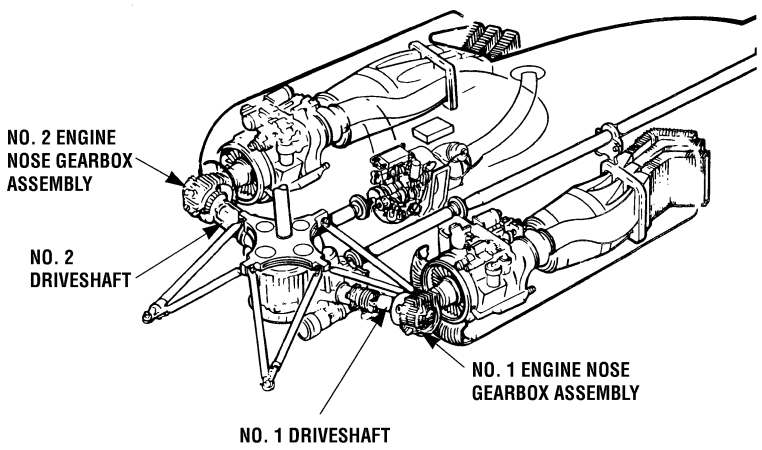
06-93-43
85-143

NOTES

E. Major components of the AH-64A powertrain

1. Engine nose gearbox assemblies (2)
2. Main transmission assembly
3. Intermediate gearbox assembly
4. Tail rotor gearbox assembly
5. Drive shaft assemblies (7)
6. Main rotor drive shaft

ENGINE NOSE GEARBOX ASSEMBLIES



06-93-16
83-376B

NOTES

F. Engine nose gearboxes (NGBs)

1. The NGBs drive the main transmission through the number 1 and 2 input drive shafts.

2. The NGBs change the angle of drive 90 degrees and reduce engine RPM output from 20,952 to 9,841 RPM. This lower rpm results in increased torque.

3. One NGB is mounted on the forward frame of each engine. (The # 1 NGB is on the left side of the helicopter in front of the #1 engine and the # 2 NGB is on the right side of the helicopter in front of the #2 engine.)

4. The NGB housing is made of magnesium alloy and is completely finned for cooling.

5. The oil system is self contained, using the lower housing as an oil sump.

6. An oil level sight plug permits flight and maintenance personnel to visually check oil level when the engines are not operating.

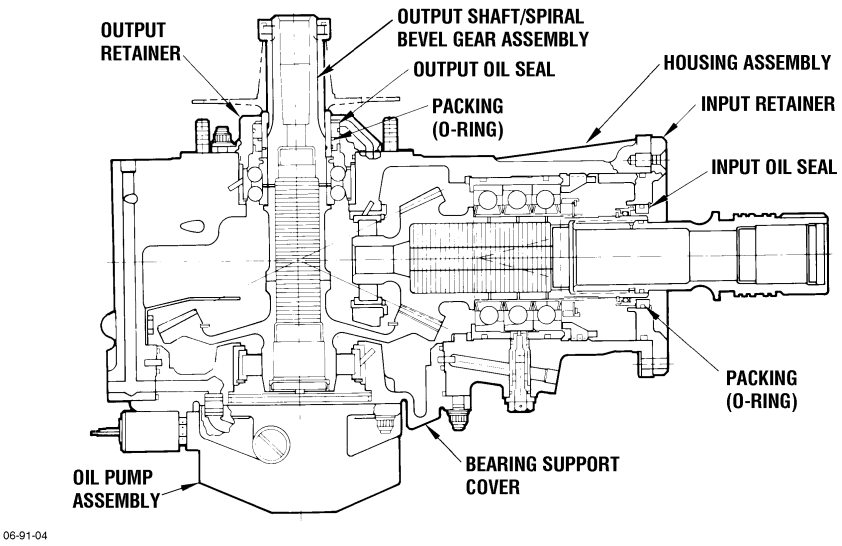
7. The hollow input and output shafts have oil wicking disks installed.

8. Oil pressure and temperature are monitored by the Fault Detection/Location System (FD/LS).

9. Twice the normal backlash is provided to accommodate high thermal expansion of the bevel gears during emergency operations after complete loss of lubricating oil.

10. Bearings using silver plated M50 steel races provide lubrication requirements during initial starts and assist lubrication during emergency operations after complete loss of lubricating oil.

NOSE GEARBOX HOUSING ASSEMBLY COMPONENTS - DESCRIPTION



NOTES

G. Nose gearbox major components

1. Housing assembly

a. Houses and supports the major components in the engine nose gearbox.

b. Completely finned for cooling.

c. Made of lightweight magnesium alloy.

d. Housing assembly components

(1) Input retainer

(a) Supports the input seal.

(b) Installed on the input side of the housing assembly.

(2) Output retainer

(a) Supports the output seal.

(b) Installed on the output side of the housing assembly.

(3) Bearing support cover

(a) Supports the oil pump and the output shaft roller bearing.

(b) Mounted on the opposite side of the output shaft/spiral bevel gear assembly.

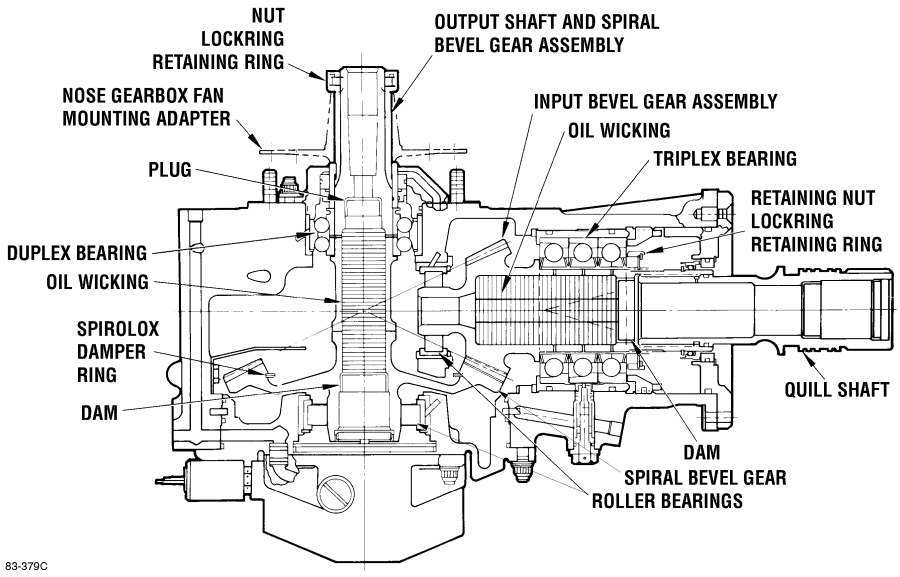
(4) Input and output oil seals

(a) Retain the oil within the housing assembly.

(b) The input seal is installed in the input retainer and the output seal is installed in the output retainer.

(c) The seals are carbon/magnetic type seals and incorporate packings for better oil retention.

NOSE GEARBOX MAJOR COMPONENTS - DESCRIPTION



NOTES

2. Quill shaft

   a. Transmits power from the engine output shaft to drive the NGB.

   b. Splined to the engine output shaft and input bevel gear assembly.

   c. The quill shaft is a floating shaft that moves in and out between the engine output shaft and input bevel gear. One packing is installed on the gearbox end and three packings on the engine output shaft end of the quill shaft.

3. Input bevel gear assembly

   a. Transmits power from the quill shaft to the output shaft assembly spiral bevel gear.

   b. Positioned on the input side of the nose gearbox and is retained in place by a retaining nut, lock ring, and retaining ring.

   c. Made of steel and splined to accept the quill shaft.

   d. Thirty felt disks are installed inside the hollow shaft for oil wicking.

   e. A dam is installed to hold the felt disks in position.

4. Output shaft/spiral bevel gear assembly

   a. Transmits reduced rpm to the NGB fan mounting adapter to drive the main transmission input shaft.

   b. Installed between the input bevel gear, the bearing support cover, and the retainer.

   c. Integral with the output shaft assembly.

   d. Thirty-two felt disks are installed inside the hollow shaft for oil wicking.

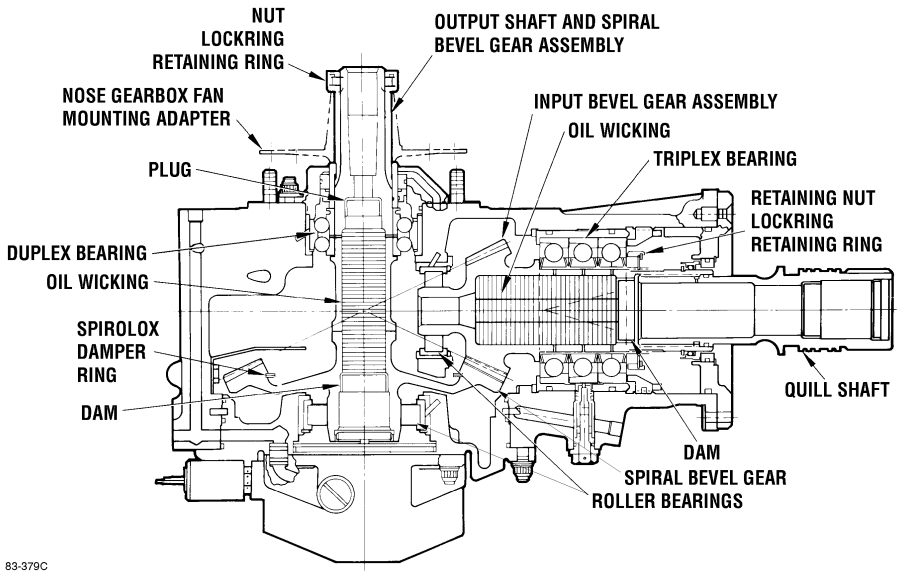
   e. A plug and a dam are installed to hold the felt disks in position. The dam is drilled to allow lubrication of the duplex bearing.

   f. The output shaft and spiral bevel gear assembly is made to accept the NGB fan mounting adapter on the output end.

   g. The spiral bevel gear end of the output shaft is splined to accept and drive the oil pump.

   h. The output shaft's spiral bevel gear has a spirolox ring installed to dampen natural harmonic frequencies, thereby allowing for a smaller gearbox.

NOSE GEARBOX MAJOR COMPONENTS - DESCRIPTION



NOTES

5. Triplex bearing

    a. Supports the center section of the input bevel gear assembly.

    b. Transmits radial and axial loads from the input bevel gear assembly to the housing.

6. Duplex bearing - supports the shaft section of the output shaft assembly.

7. Roller bearings (2)

    a. The roller bearing supports the bevel gear end of the input bevel gear. The bearings transmit radial loads only from the input bevel gear to the housing.

    b. Data indicates that the nose gearbox input and output roller bearing sleeves appear to be creeping, causing unacceptable wear on the inner diameter of the sleeve and metal particle contamination in the nose gearbox lubrication system. ECP 1213 titled "Nose Gearbox Bearing Outer Race Retainment" incorporates retaining pins that prevent outer race rotation and resultant wear. This repair occurs when the nose gearboxes are returned to depot for overhaul.

8. Nose gearbox fan mounting adapter

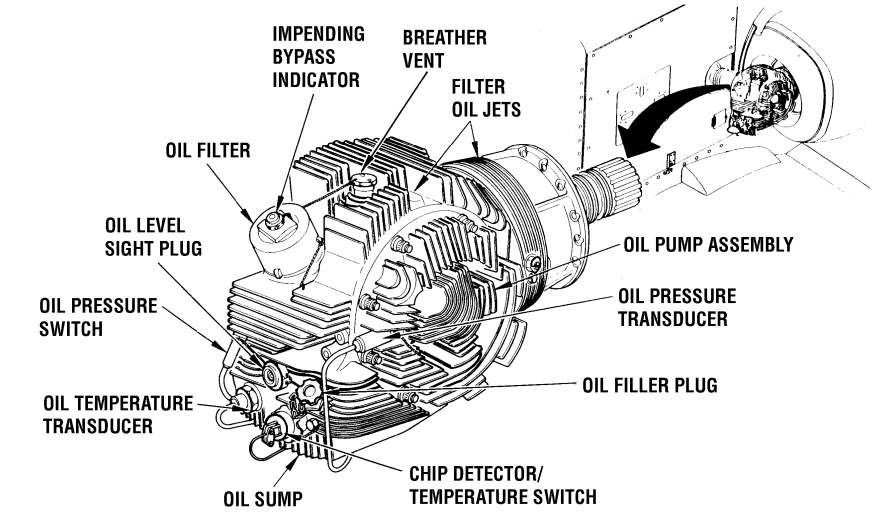
    a. Provides a mounting pad for the NGB fan.

    b. Splined to the output shaft assembly and held in place by a nut, lock ring, and retaining ring.

    c. The mounting adapter is a round steel ring with five access holes to aid in removing and installing input coupling retaining bolts.

9. Oil pump housing - Houses and supports the oil pump.

NOSE GEARBOX LUBRICATION SYSTEM



NOTES

H. Nose gearbox lubrication

1. Provides lubrication for normal and emergency operations.

2. Self-contained oil system.

3. The oil sump is integral with the lower housing.

4. Capacity of oil sump is 5.5 U.S. pints (1.18 liters) for each nose gearbox. Required lubricating oil is:

   a. MIL-L-23699 - Use in outside air temperatures of -25EF (-32EC) and above.

   b. MIL-L-7808 - Use in outside air temperatures of -25EF (-32EC) and below.

5. Nose gearbox lubrication system components

   a. Oil pump assembly

   b. Oil pressure transducer

   c. Oil pressure switch

   d. Oil filter with impending bypass indicator

   e. Chip detector/temperature switch

   f. Oil temperature transducer

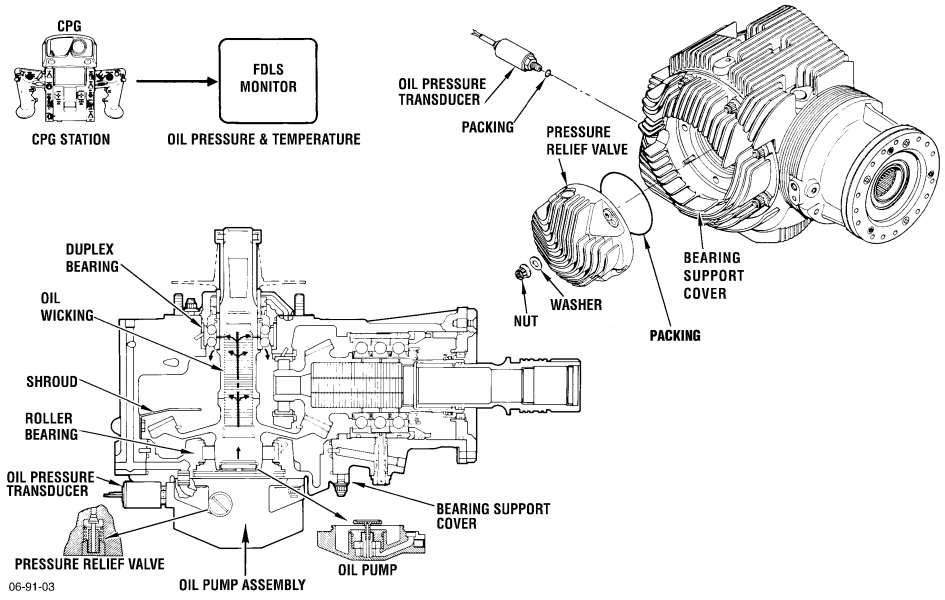
   g. Oil level sight plug

   h. Oil filler plug

   i. Breather vent

   j. NGB oil jets

NOSE GEARBOX OIL PUMP ASSEMBLY AND OIL PRESSURE TRANSDUCER



NOTES

6. Nose gearbox lubrication system component description

a. Oil pump assembly

(1) Pressurizes the oil system and delivers oil to lubricate the engine NGB components.

(2) Pump is integral with the bearing support cover and includes the oil pressure relief valve.

(3) The oil pump is rated at 2.3 gpm (8.7 LPM) and 50 psi (344 kPa) at 9,841 rpm. Sprays non-filtered oil through the lubrication hole in the output shaft dam to saturate the felt wicking disks and lubricate the duplex bearing. The felt disks provide filtering action prior to the oil reaching the bearing. Oil pressure is also supplied to three (3) filtered oil jets used to lubricate the triplex bearing, input bevel gear roller bearing, and gear mesh.

(4) In case of complete loss of lubricating oil, the trapped oil in the felt wicking disks is slung out by centrifugal force to provide emergency lubrication for a minimum of 30 minutes.

(5) The oil pressure relief valve controls oil pressure.

(a) Rated at 7.5 gpm (28.38 LPM).

(b) Valve cracking pressure 68 "4 psi (468 "27.6 kPa) and full bypass flow at 90 psi (620 kPa).

b. Oil pressure transducer

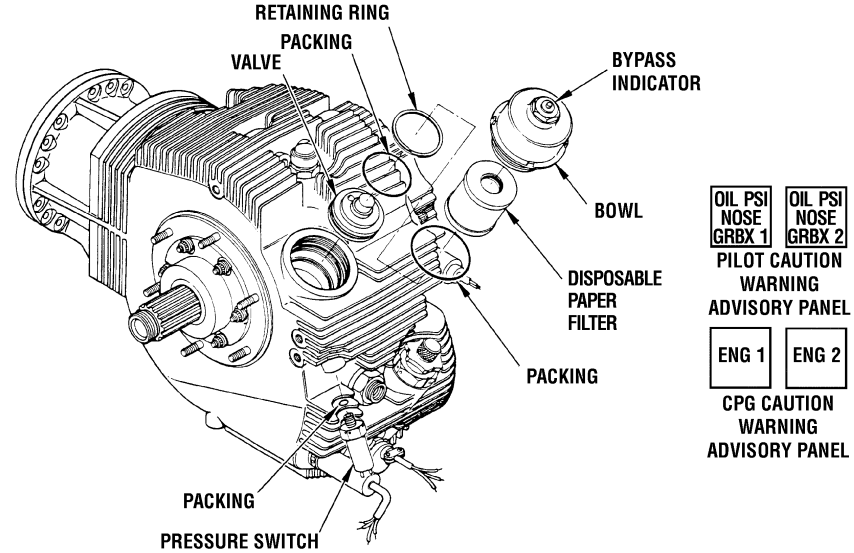
(1) Transmits a true pressure reading to the fault detection/location system (FD/LS).

(2) Mounted on the forward side of the oil pump assembly.

(3) Receives 0-5 VDC operating power from LH/RH FAB MRTU Type I.

071-(

NOSE GEARBOX OIL PRESSURE SWITCH AND OIL FILTER



NOTES

c. Oil pressure switch

(1) Monitors the oil system pressure during nose gearbox operation.

(2) Installed on the front of the housing assembly.

(3) The oil pressure switch is connected to a caution light in the pilot's and CPG's crew station.

(a) Turns off the pilot's OIL PSI NOSE GRBX 1 or 2 caution lights and the CPG's ENG 1 or 2 caution lights when oil pressure is 45 psi (310 kPa) increasing.

(b) Turns on the pilot's OIL PSI NOSE GRBX 1 or 2 caution lights and the CPG's ENG 1 or 2 caution lights when oil pressure is 30-26 psi (206-179 kPa) decreasing.

NOTE: If the oil filter becomes clogged, oil bypasses the filter prior to illumination of the OIL PSI NOSE GRBX caution light. This is due to bypass valve and pressure switch settings.

d. Oil filter with impending bypass indicator

(1) Removes impurities from the oil, visually warns of pressure differential problems in the oil filter, and bypasses oil around the filter when required.

(2) Mounted on the upper forward section of the housing assembly.

(3) Oil filter components

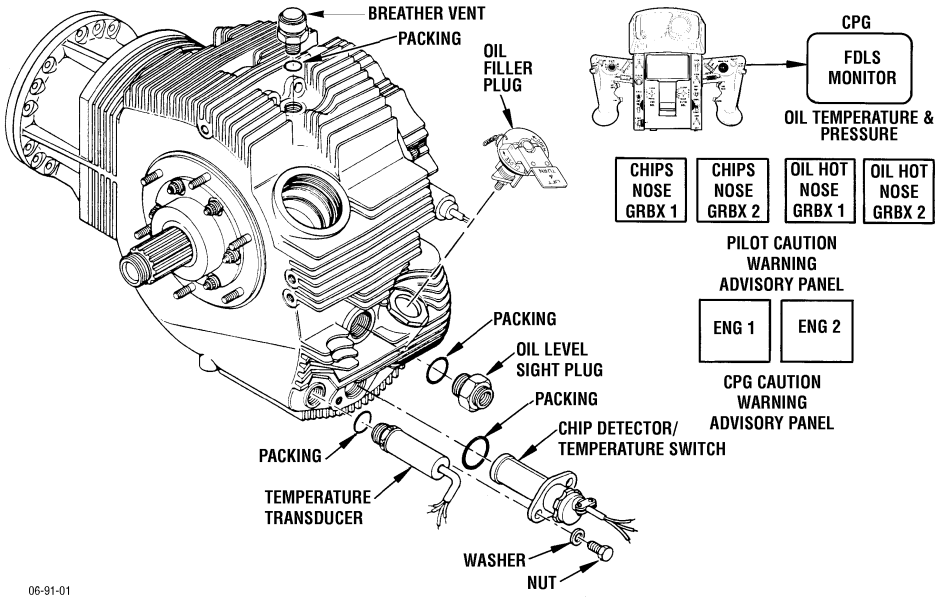
(a) 12 micron disposable filter - installed inside the filter bowl.

(b) Impending bypass indicator - installed on top of the filter bowl which pops out when a differential pressure across the filter is greater than 23 "2 psid (158 "13.7 kPa).

(c) NGB impending bypass indicators are resetable.

(d) Oil bypass valve - located on the housing below the oil filter, which allows oil to bypass the oil filter once the valve setting of 38 "4 psid (262 "27.5 kPa) is exceeded.

NOSE GEARBOX SENSORS/INDICATORS



NOTES

e. Chip detector/temperature switch

(1) Senses the presence of large metal chips in the oil, burns off small metal particles (fuzz), and monitors the oil temperature.

(2) Installed on the forward lower center of the oil sump.

(3) Senses the presence of large metal particles (chips which the capacitor discharge does not burn off) in the gearbox oil and causes, the CHIPS NOSE GRBX 1 or 2 caution light on the pilot's caution/warning/advisory (C/W/A) panel to come on and the ENG 1 or 2 caution lights on the CPG C/W/A panel to come on.

(4) A capacitor is housed in the body of the chip detector and discharges to burn off any accumulation of small metal particles (fuzz suppression) without causing the pilot's CHIPS NOSE GRBX 1 or 2 or the CPG's ENG 1 or 2 caution lights to come on.

(5) The temperature switch causes the OIL HOT NOSE GRBX 1 or 2 caution light in pilot's station and the ENG 1 or ENG 2 caution light in CPG's station to illuminate at 274 - 294EF (134 - 145EC) increasing.

(6) The caution lights in both crewstations go out at 264 - 244EF (128 - 117EC) decreasing.

f. Oil temperature transducer

(1) Transmits a temperature reading to the Fault Detection/Location System (FD/LS).

(2) Installed in the lower forward side of the oil sump.

(3) Connected to the FD/LS.

(4) Receives 28 VDC operating voltage from the emergency DC bus through the engine start circuit breaker.

(5) Supplies 0-10 VDC to MRTU Type I located in the corresponding FAB. This signal is directly monitored by FD/LS.

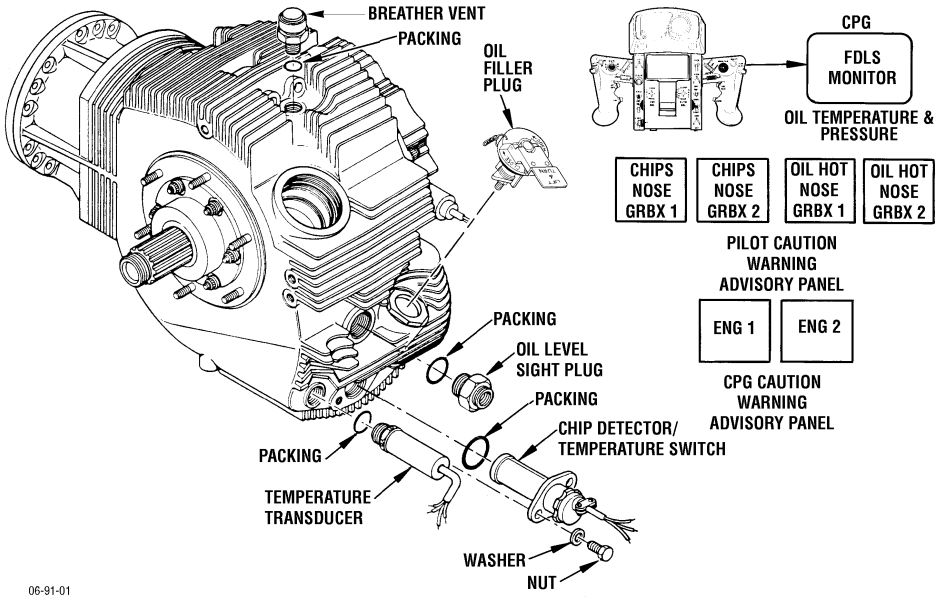
g. Oil level sight plug

(1) Permits flight and maintenance personnel to visually inspect the quantity of oil in the oil sump when engines are not operating.

(2) Mounted on the forward side of the oil sump.

(3) The oil level sight plug is a "bull's-eye" type.

NOSE GEARBOX SENSORS/INDICATORS



NOTES

h. Oil filler plug

(1) Used to service the NGB.

(2) Located on the forward section of the oil sump.

(3) There are two versions of this plug fielded.

(a) The early version consists of a filler plug, o-ring, cap, and filter screen.

(b) The current (new) version consists of an over-center locking feature and an o-ring, but does not have a filter screen.

(4) New oil filler plug

(a) The leakage of oil laden air from the NGB breather vent has been a chronic field problem because the oil mist is not vented overboard. Instead, it is carried by the cooling fans into the transmission deck where it pollutes the bay area environment.

(b) The new filler plug prevents the initial leakage of air into the NGB and eliminates the secondary effects of air and oil leaks from the breather vent.

(c) The new oil filler plug utilizes a face sealing o-ring and an over-center locking feature that maintains a controlled squeeze on the o-ring. (Prevents air leaks).

(d) The ultimate effect of the new oil filler plug reduces the amount of mist entering the transmission deck and polluting the aircraft environment. This reduction in pollution enhances the overall reliability and maintainability of the helicopter.

(e) The reliability and maintainability of the oil filler plug itself is also improved.

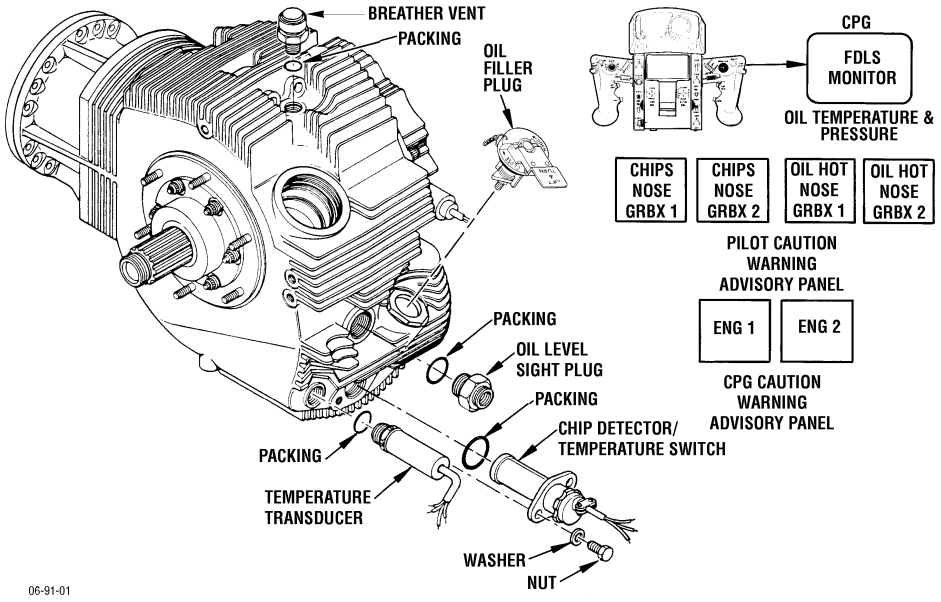
NOTE: The older oil filler plugs and breather vents are replaced through attrition.

i. Breather vent

(1) Allows pressure to equalize within the NGB.

(2) Mounted on top of the housing assembly.

NOSE GEARBOX SENSORS/INDICATORS

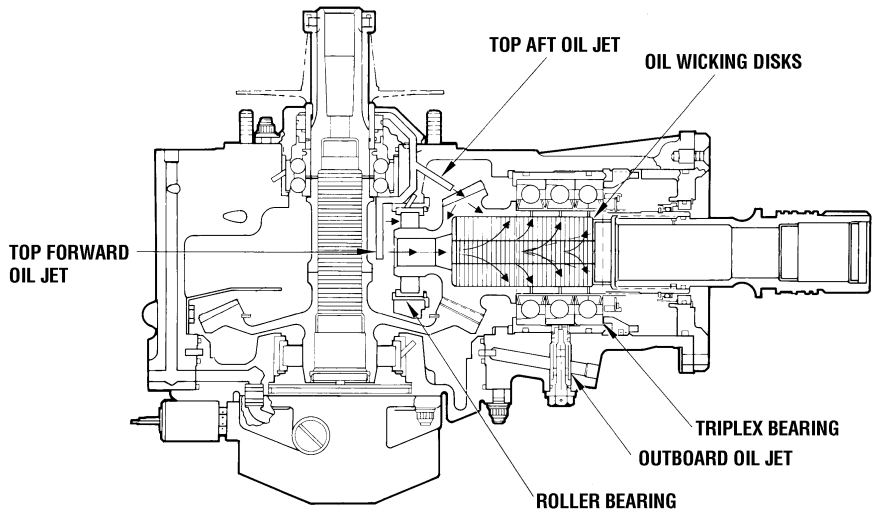


NOTES

(3) An early version is an aluminum plug with an air filter made of curled steel wool. The current (new) breather vent is an aluminum vent tube with four baffles.

(4) The newer version is preferred for use with the new oil filler plug because it reduces NGB oil loss.

NOSE GEARBOX OIL JET LUBRICATION



NOTES

j. NGB oil jets

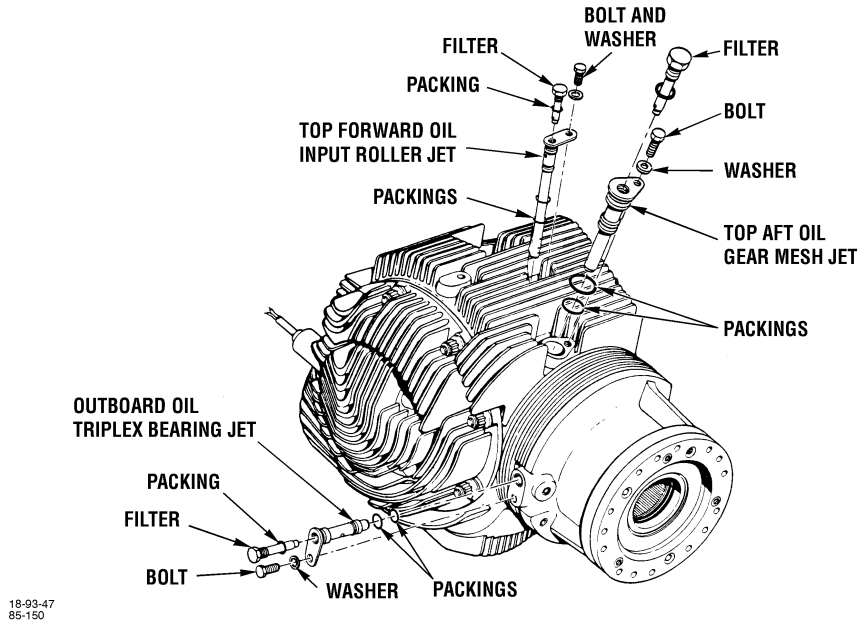
(1) Distribute pressurized, filtered oil to lubricate gearbox internal components.

(2) The jets are installed in the NGB housing.

(3) Spray pressurized filtered oil to lubricate the triplex bearing set, the roller bearing assembly, and the input bevel gear and spiral bevel gear mesh.

(4) The jets have filters to extract metal particles from the oil in the UNLIKELY event the filter goes into bypass.

LEFT NOSE GEARBOX FILTERED JETS (LOCATION)



NOTES

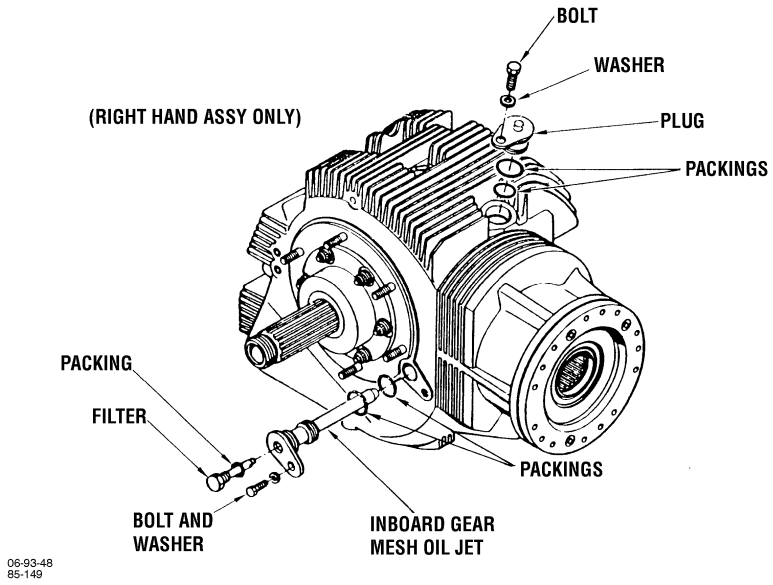
k. Left NGB filtered oil jets (3)

(1) The top, forward jet lubricates the input roller bearing and sprays oil into the input drive shaft oil wicking felt disks.

(2) The top, aft jet sprays the inboard gear mesh.

(3) The outboard jet lubricates the triplex bearing.

RIGHT NOSE GEARBOX FILTERED JET (LOCATION)



NOTES

l. Right NGB filtered oil jets (2)

(1) The right NGB has the triplex bearing oil jet inboard by the output shaft.

(2) The hole for the top aft jet has a plug installed.

m. Left and right NGB oil jet differences

(1) The left NGB's top, aft jet is installed within a plug body that is mounted on the gearbox housing behind the vent.

(2) The right NGB has only a plug body in this location. The jet that supplies oil to the gear-mesh is on the inside face of the output shaft side of the gearbox. Access to this jet requires removal of the cooling fan assembly.

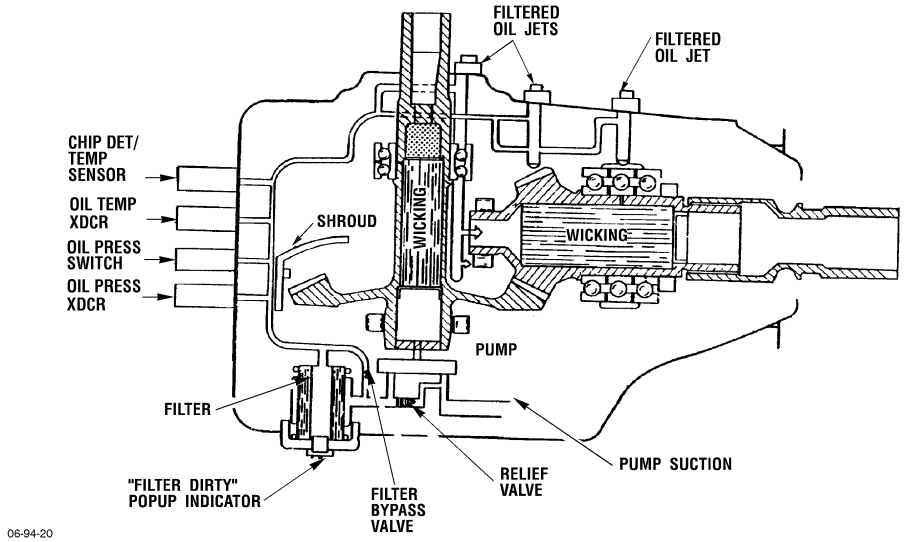
(3) The reason for the difference is due to the mounting angles that the gearboxes have.

(a) Both are installed at an approximate 18**2**E angle.

(b) The right NGB has to have a different spray pattern to provide positive lubrication due to its installation angle and gear rotation.

n. The filtered oil jets are replaceable at the AVUM level. Refer to TM 55-1520-238-23.

NOSE GEARBOX OIL SUPPLY



NOTES

I. NGB lubrication system operation

1. Power to drive the oil pump is provided by the NGB output gear shaft.

2. The oil pump draws oil from the gearbox sump area and pressurizes the oil. This oil is pressurized to approximately 50 PSI before being routed to the filter.

3. Unfiltered oil is directed onto the output gear shaft felt wicking by an oil passage drilled through the pump drive shaft.

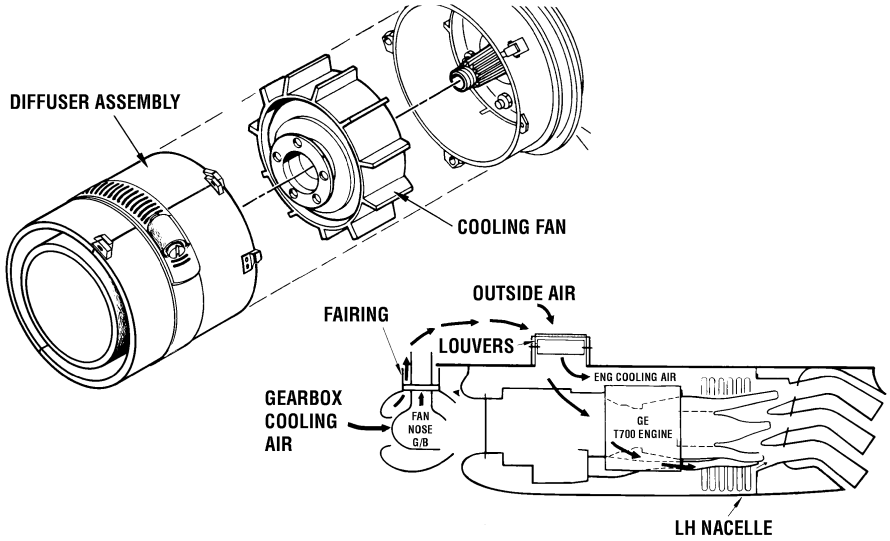
4. Oil from the pump is routed to the filter, where impurities in the oil are removed. If the filter becomes clogged, oil bypasses the filter and is sent through internal oil passages in the gearbox housing to the jets.

5. Before reaching the jets, the oil is checked for low pressure, exact pressure, exact temperature, and metal chips/high oil temperature.

6. The screens (filters) in the three filtered oil jets remove any large particles from the oil that may have gone past the filter when the filter is in bypass. Oil is sprayed on the input roller bearings, inside the gear shaft to the felt wicking, on the triplex bearings, and on the gear mesh. All pump pressure oil is directed at the input gear shaft assembly.

7. The output gear shaft assembly is lubricated by the oil supply in the sump and gear splash. Two parts of a shroud are bolted inside the NGB housing. This shroud redirects the splashed oil back onto the gear mesh. The gear shaft roller bearings also lubricated by this splash. The duplex bearings ride down inside the sump oil supply.

NOSE GEARBOX COOLING



NOTES

J. Nose gearbox cooling

1. The NGB cooling fan assembly maintains the engine nose gearbox within its normal operating temperature.

   a. The fan is mounted on the fan mounting adapter side of each engine nose gearbox assembly.

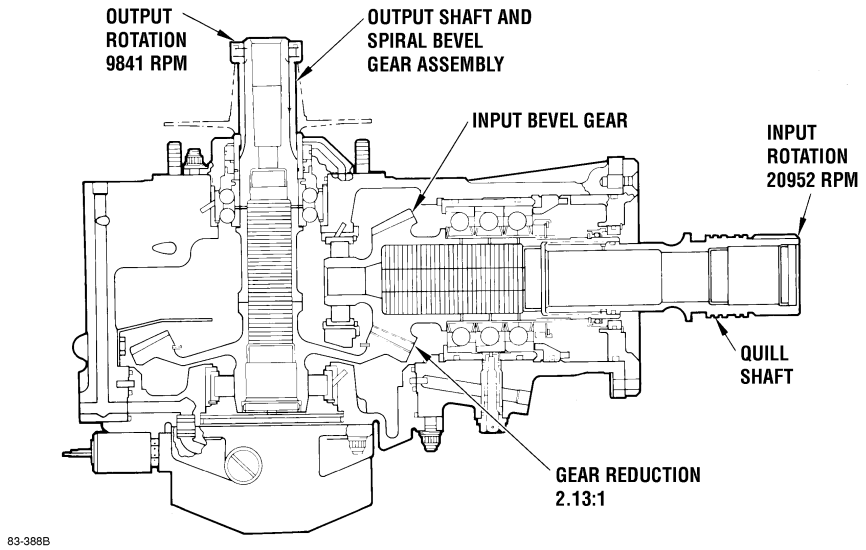
   b. The fan is shrouded by the diffuser assembly.

2. Air is drawn through the cooling fins around the gearbox, toward the transmission deck area, and is exhausted with the IR suppression system air.

3. The engine nose gearbox cooling fan impeller and diffuser are serialized and matched components. These components are not interchangeable with other assemblies.

071-(

NOSE GEARBOX OPERATION



NOTES

K. Nose gearbox operation

1. The engine NGB assemblies drive the main transmission through input drive shafts 1 and 2 while changing the angle of drive 90E. When the engines are operating at 100% N_P, the NGBs reduce engine output from 20,952 to 9,841 RPM.

2. The oil pump assemblies spray oil on the bearing and felt wicking disks in the NGB assemblies.

3. The oil pressure switch monitors oil system pressure during NGB operation. When NGB oil pressure exceeds 45 PSI increasing, the oil pressure switch turns off the pilot's OIL PSI NOSE GRBX 1 or 2 caution light and the CPG's ENG 1 or 2 caution light. When NGB oil pressure drops to 30 - 26 PSI decreasing, the caution lights illuminate.

4. The oil filter removes impurities from the oil and has an impending bypass indicator which visually warns of pressure differential problems in the oil filter, and bypasses oil around the filter when required. An impending bypass indicator pops out, providing visual indication, when a differential pressure across the filter is greater than 23 "2 PSID (filter bypass indicator button is resetable). If the oil filter becomes clogged, a bypass valve opens to allow the oil to bypass the filter when 38 "4 PSID has been exceeded.

5. The chip detector/temperature switch senses the presence of large metal chips in the oil and monitors oil temperature. When large metal chips are sensed in the NGB oil, the detector causes the CHIPS NOSE GRBX 1 or 2 caution light on the pilot's C/W/A panel and the ENG 1 or 2 caution light on the GPG's C/W/A panel, to illuminate. A capacitor discharges to burn off any accumulation of small metal particles (fuzz suppression) without causing the caution lights to illuminate.

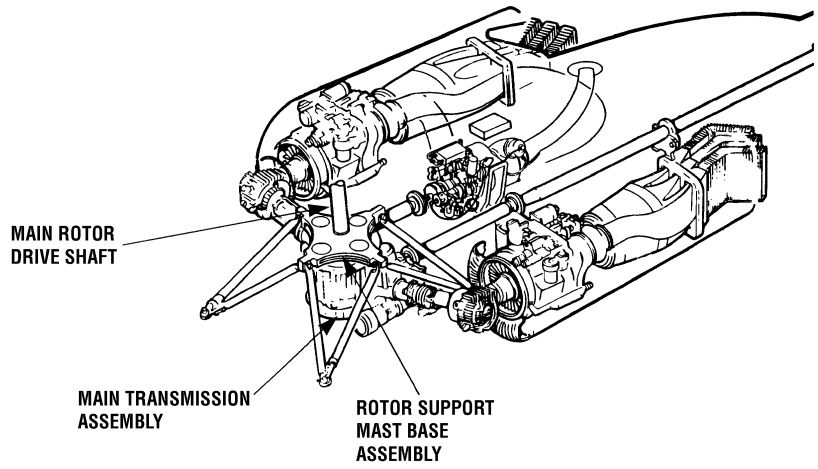
6. The NGB cooling fan forces cooling air around the NGB to maintain operating temperatures at 250EF to 275EF (121EC to 135EC) at 100% N_P. The vaneaxial fan pulls cooling air around the cooling fins on the NGB housing. The air is forced through NGB fairings out to the transmission deck, and exhausted through the IR suppression system.

7. The oil pressure transducer monitors and transmits NGB operating oil pressure to FD/LS.

8. The oil level sight plug permits flight and maintenance personnel to visually inspect the oil level when the engines are not operating.

9. The NGBs transmit power to the main transmission via input drive shafts 1 and 2 respectively.

MAIN TRANSMISSION ASSEMBLY



NOTES

L. Main transmission assembly

1. Transmits power from the NGBs to the rotor system.

2. Changes the angle of drive.

3. Through three stages of gear reduction, it reduces output rpm and increases torque.

   a. Reduces NGB 9,841 RPM to main rotor 289 RPM

   b. Reduces NGB 9,841 RPM to tail rotor 4,815 RPM

4. Drives the following accessories

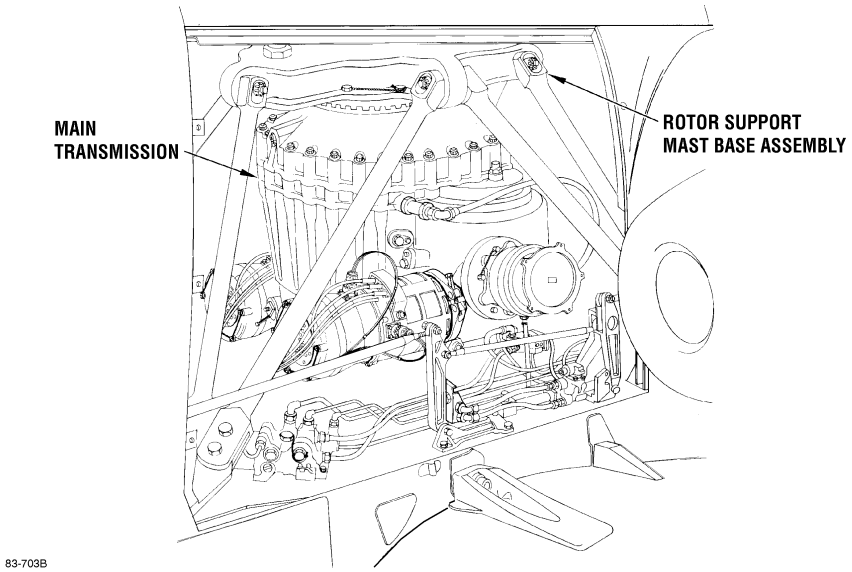
   a. Two generators

   b. Two hydraulic pumps

   c. Shaft driven compressor (SDC)

   d. Primary and accessory oil pumps

TRANSMISSION LOCATION



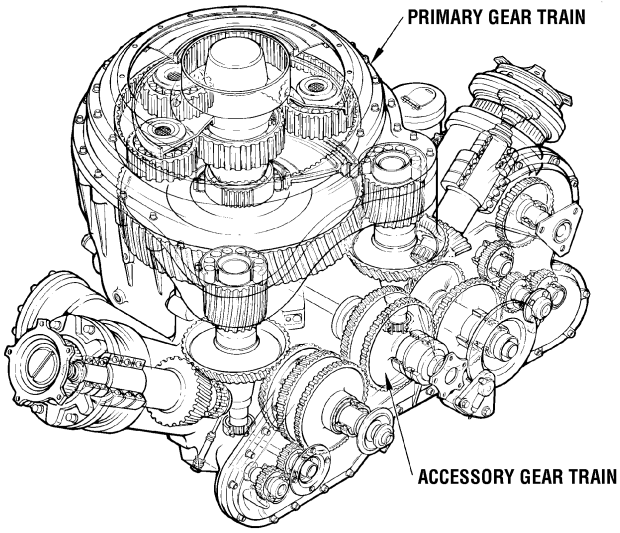
NOTES

5. Mounted beneath the main rotor mast support base.

6. Coupled to the mast support base by a cervic coupling which transmits torsional loads from the transmission to the mast support base. Flight loads are not transmitted to the transmission. This permits the use of a smaller transmission with a longer service life.

7. Uses power from the APU to drive the accessories when the main rotor speed is below 95% N_R.

MAIN TRANSMISSION ASSEMBLY - DESCRIPTION



NOTES

8. Bearings using silver plated steel races provide lubrication during the start period and aid in emergency lubrication.

9. Main transmission emergency features and capabilities

   a. Twice the normal backlash is incorporated into the bevel gears to accommodate high thermal expansion of the gears during emergency operation.

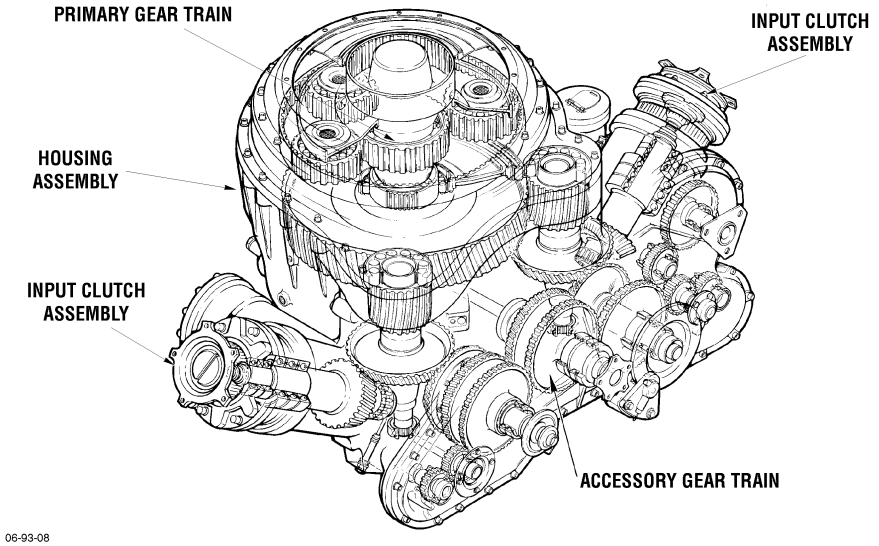
   b. One engine may be fully de-coupled for single engine operations.

   c. Both engines may be fully decoupled to permit autorotation.

   d. The transmission can operate with one of its two oil systems not functioning.

   e. The transmission can operate for a minimum of thirty minutes after complete loss of lubrication.

MAIN TRANSMISSION ASSEMBLY- MAJOR COMPONENTS



NOTES

10. Main transmission major components

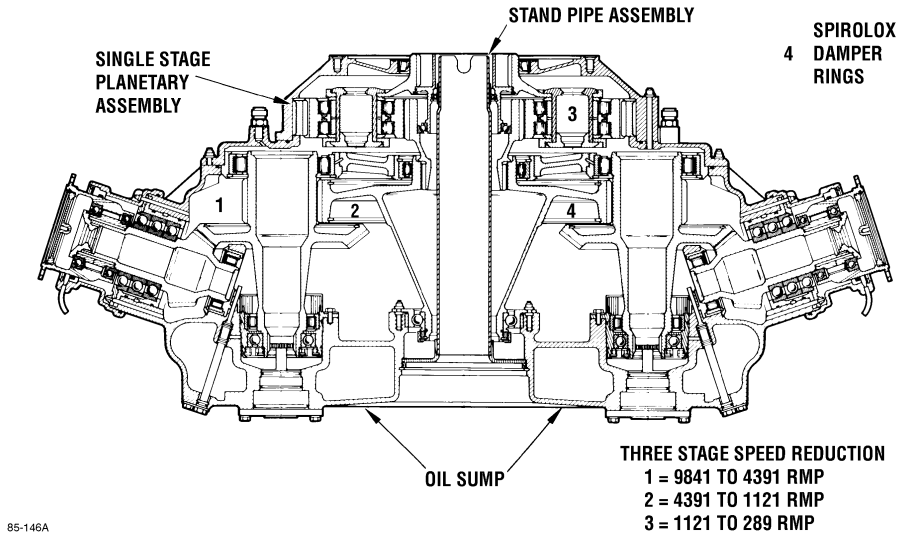
    a. Housing assembly

    b. Two input clutch assemblies

    c. Primary geartrain

    d. Accessory geartrain

MAIN TRANSMISSION HOUSING ASSEMBLY



NOTES

M. Main transmission major component description

1. Housing assembly

a. Houses primary and accessory geartrain.

b. Provides two oil sumps and an internal oil gallery for the lubrication system.

c. Made of lightweight magnesium alloy.

d. Three piece construction

(1) Upper housing - includes the cervic coupling.

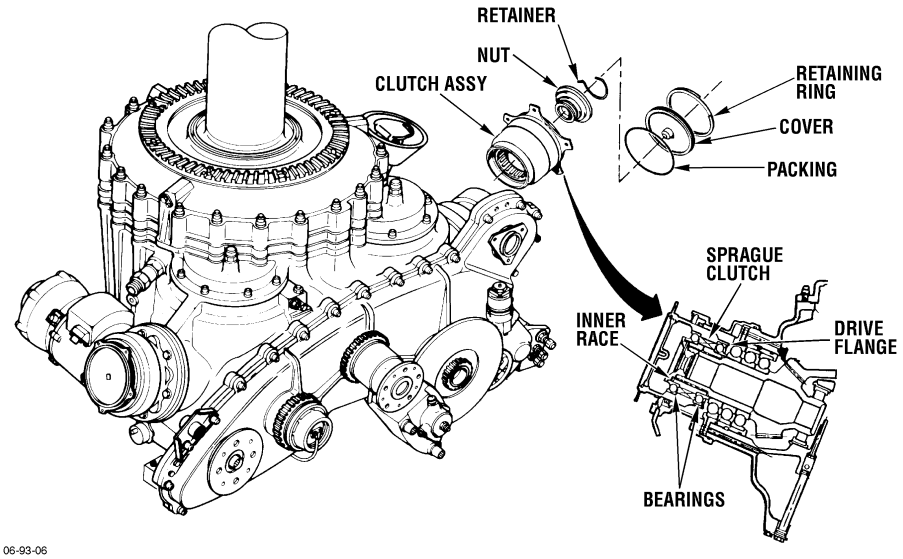
(2) Intermediate stage gear support - (discussed in lubrication section).

(3) Lower housing - incorporates two internal oil sumps and their respective oil pumps.

e. Provides support for input clutch assemblies and mounting points for gear driven accessories.

f. A standpipe assembly extends through the vertical length of the transmission, providing a route for the air data system electrical harness.

INPUT CLUTCH ASSEMBLY



NOTES

2. Input clutch assembly

   a. Provide drive and disengaging capabilities for the main transmission assembly.

   b. Identical clutches are installed in the lower section of the main transmission on both the left and right sides.

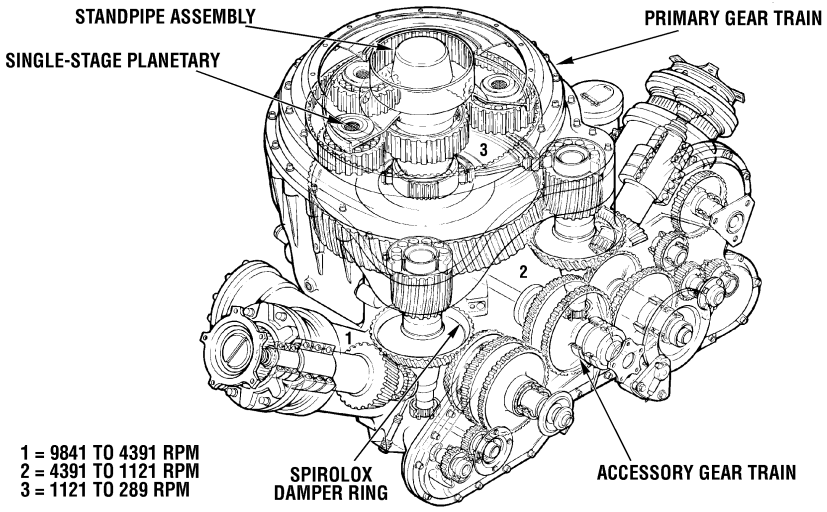
   c. The input clutches are free-wheeling type sprag assemblies.

   d. A two hour over-running period is permissible without any impairment.

   e. Complete loss of lubrication oil during an overrunning condition does not effect the transmission's 30 minute emergency operation specifications.

   f. An improved input clutch assembly is now available. The new configuration, identified as a -9, is a one-for-one replacement for the existing -7 configuration. The improved design increases the life of the clutch assembly and decreases wear. Change out is through attrition.

MAIN TRANSMISSION
PRIMARY GEAR TRAIN



NOTES

3. Main transmission primary gear train

   a. Changes the angle of drive that is delivered by the nose gearboxes, and transmits reduced RPM from the nose gearboxes to the main and tail rotor systems.

   b. The primary gear train provides three stages of speed reduction.

      (1) First stage speed reduction occurs where the input pinion bevel gear and the cluster gear mesh together. RPM is reduced from 9,481 to 4,391.

      (2) Second stage speed reduction occurs where the cluster gear and the intermediate helical gear mesh together. RPM is reduced from 4,391 to 1,121.

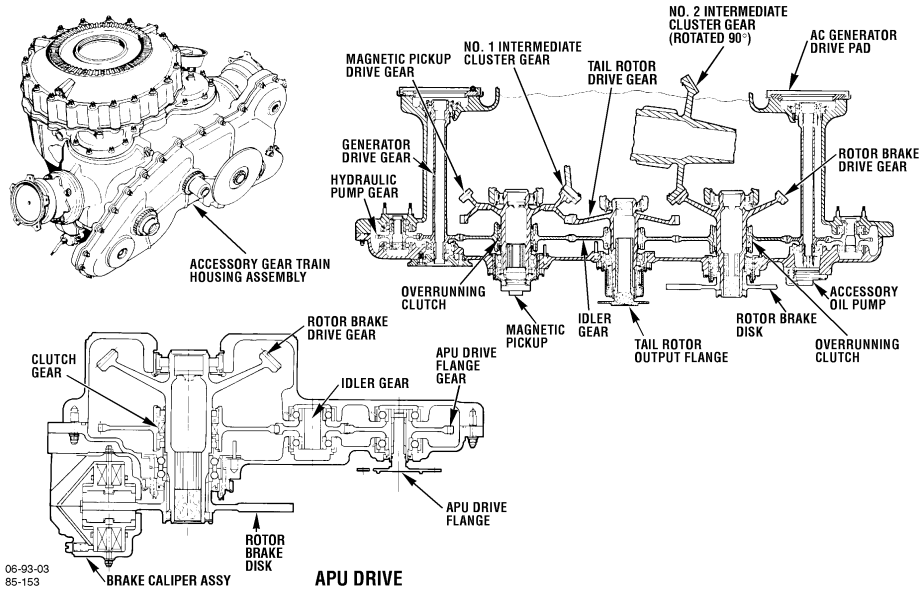
      (3) Third stage speed reduction occurs in the planetary gear assembly. RPM is reduced from 1,121 to 289.

   c. The tail rotor output shaft is driven from the left hand cluster gear.

   d. The lower portion of both cluster gears are internally splined to drive primary oil pumps.

   e. Spirolox damper rings dampen the cluster gears and intermediate helical gears natural frequencies, allowing for smaller gears and a smaller main transmission.

ACCESSORY GEAR TRAIN HOUSING ASSEMBLY AND ACCESSORY GEAR TRAIN



NOTES

4. Accessory geartrain housing assembly

   a. Provides support for the accessory geartrain and components.

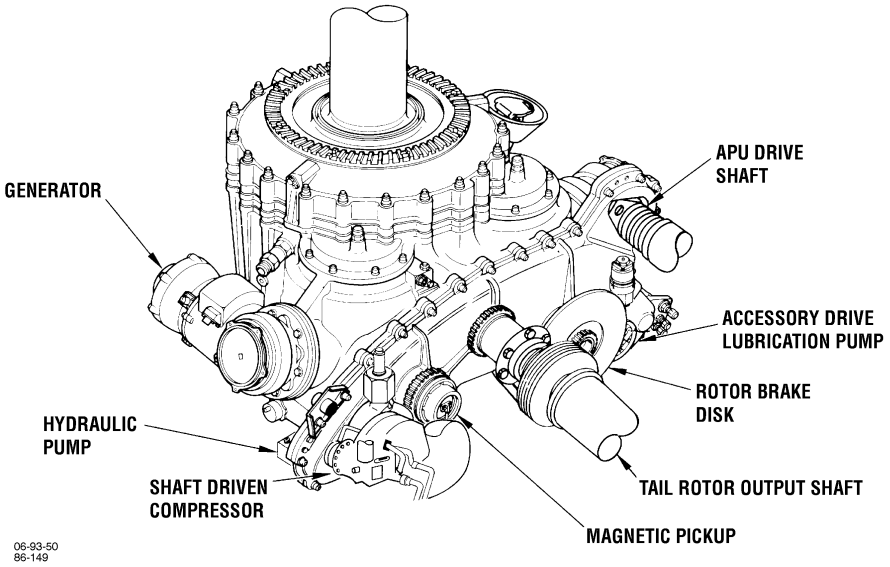
   b. Makes up the rear section of the main transmission assembly.

   c. The accessory geartrain is driven by the intermediate stage cluster gears.

   d. Two sprague clutch assemblies (overrunning clutches) and a roller bearing set freewheel without turning the primary geartrain and tail rotor assembly during ground operations.

   e. The APU drives the accessory geartrain during ground operations, or when the main rotor speed is less than 95% N_R.

ACCESSORY GEAR TRAIN DRIVEN COMPONENTS



NOTES

f. Components driven during normal operations

(1) APU drive shaft

(2) Generators (2)

(3) Hydraulic pumps (2)

(4) Shaft driven compressor

(5) Accessory drive lubrication pump

(6) Rotor brake disk

(7) Magnetic pickup

(8) Tail rotor output shaft

g. Components driven during APU ground operations

(1) Generator (2)

(2) Hydraulic pumps (2)

(3) Shaft driven compressor

(4) Accessory drive lubrication pump

5. APU drive shaft (discussed in the drive shaft section of this course).

6. Generators (2)

a. Provides ballistic protection for the main transmission oil sumps.

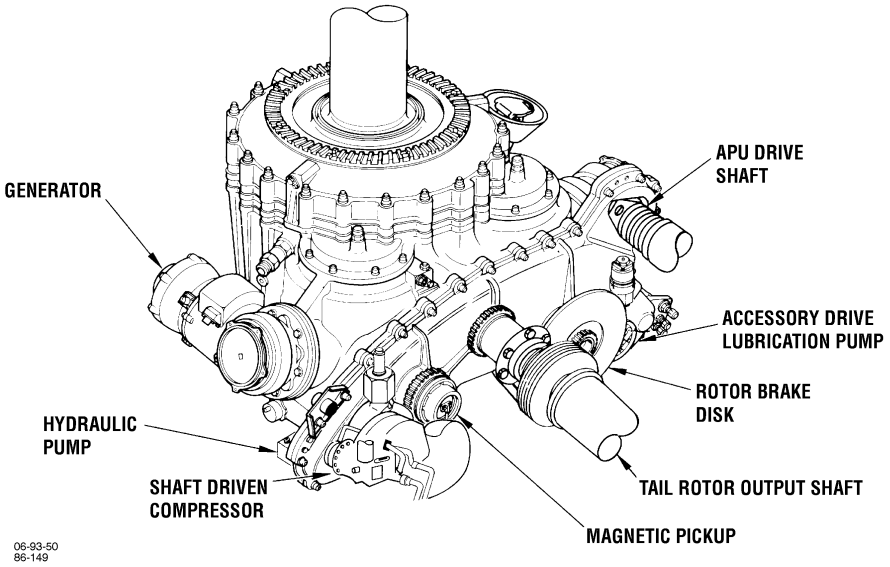
b. Installed on both sides of the transmission.

7. Hydraulic pumps (2)

a. Pressurizes hydraulic fluid during engine or APU operation.

b. Primary and utility hydraulic pumps mounted on left and right forward drive pads of accessory geartrain housing.

ACCESSORY GEAR TRAIN DRIVEN COMPONENTS



NOTES

8. SDC

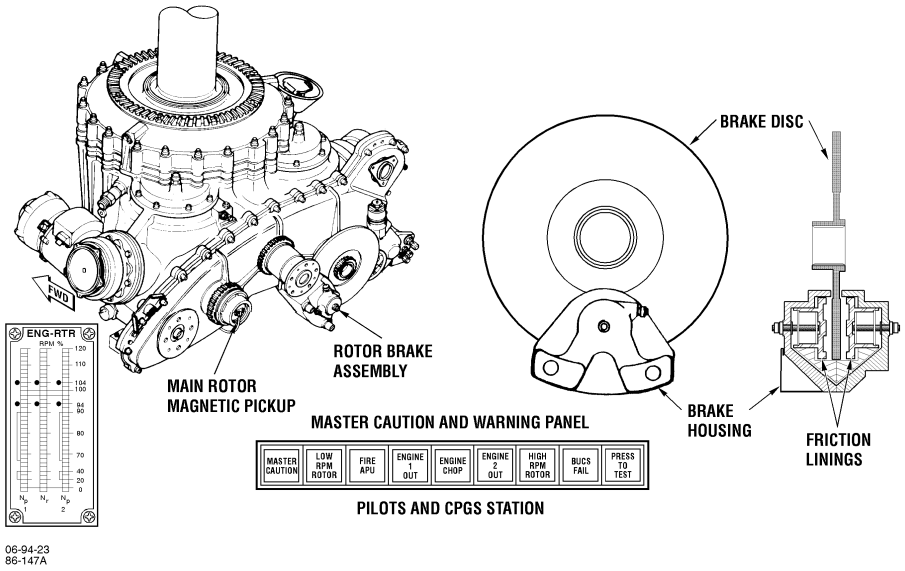
    a. Mounted on the left rear face of the accessory geartrain housing.

    b. Operation is automatic with main transmission or APU operating.

    c. Driven by the left generator spur gear.

9. Accessory drive lubrication pump (discussed during the lubrication portion of this lesson).

ROTOR BRAKE ASSEMBLY AND MAIN ROTOR MAGNETIC PICKUP



NOTES

10. Rotor brake assembly

    a. Retards or prevents rotation of the main rotor assembly to reduce turnaround time for aircraft loading and servicing, and prevent wind milling of the rotor system during gusty wind conditions.

    b. Hydraulically operated unit.

    c. Installed on the accessory gearcase center section.

    d. Consists of two components.

        (1) Steel disk - driven by the rotor brake drive gear.

        (2) Magnesium brake housing - incorporates two friction linings (pucks).

    e. There are two suppliers of rotor brake assemblies; Parker-Hannifin and Goodyear. The two assemblies are not two-way interchangeable.

11. Magnetic pickup

    a. Provides a signal for main rotor RPM readout on ENG-RTR RPM percent indicator in both crew stations.

    b. Illuminates the HIGH RPM ROTOR warning light above:

        (1) 104% N_R (-701 engine).

        (2) 108% N_R (-701C engine).

    c. Illuminates the LOW RPM ROTOR warning light below 94% N_R.

    d. Mounted on the left face of the accessory geartrain housing.

    e. Changes primary geartrain rotating motion to an electrical impulse.

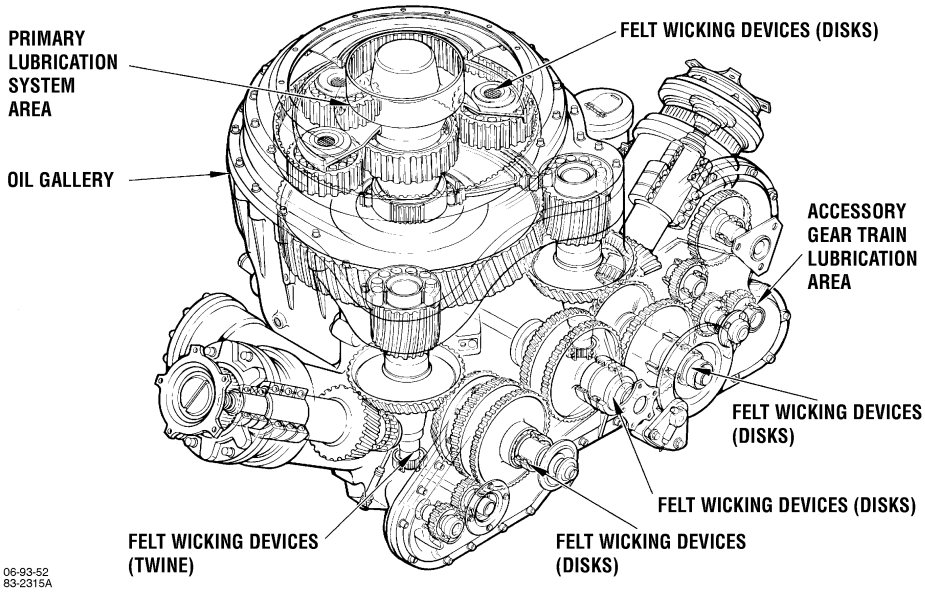
    f. Picks up the impulses from the left intermediate cluster gear.

CAUTION

To prevent damage to magnetic pickup alignment pin, do not rotate magnetic pickup during removal or installation. Twisting the magnetic pickup damages the alignment pin and magnetic pickup.

12. Tail rotor drive shaft (discussed in the drive shaft portion of this lesson).

MAIN TRANSMISSION LUBRICATION SYSTEM



NOTES

N. Main transmission lubrication system

1. Provides lubricating oil for the primary and accessory geartrains during normal and emergency transmission operations.

2. Contains 45 pints (21.28 liters) or 5.625 gallons of MIL-L-23699 or MIL-L-7808 lubricating oil. (Refer to Technical Manual for temperature range usage.)

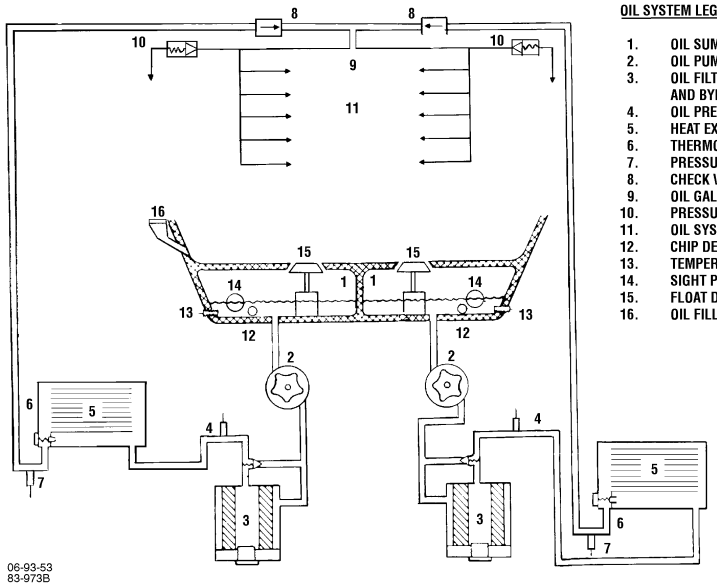
3. Felt wicking devices provide emergency lubrication for a minimum of thirty minutes after complete loss of lubricating oil.

4. Emergency lubrication oil is slung out by centrifugal force or is gravity fed to lubricate components.

5. Contains a primary lubrication system, an oil gallery and an accessory lubrication system.

071-(

DUAL LUBRICATION SYSTEM



OIL SYSTEM LEGEND

1. OIL SUMP (2)
2. OIL PUMP (2)
3. OIL FILTER (2) WITH IMPENDING BYPASS INDICATOR AND BYPASS VALVE
4. OIL PRESSURE SWITCH (2)
5. HEAT EXCHANGER (2)
6. THERMOSTATIC BYPASS VALVE (2)
7. PRESSURE TRANSDUCER (2)
8. CHECK VALVE (2)
9. OIL GALLERY
10. PRESSURE RELIEF VALVE
11. OIL SYSTEM JETS (10)
12. CHIP DETECTOR/TEMPERATURE SWITCH (2)
13. TEMPERATURE TRANSDUCER (2)
14. SIGHT PLUG (2)
15. FLOAT DIVERTER VALVE (2)
16. OIL FILLER

NOTES

O. Primary lubrication system

1. Contains two identical primary oil subsystems.

2. Oil subsystem components

a. Oil sump

b. Oil pump

c. Oil filter with impending bypass indicator and oil filter bypass valves

d. Oil pressure switch

e. Heat exchanger

f. Thermostatic bypass valve

g. Pressure transducer

h. Check valve

i. Oil gallery

j. Pressure relief valve

k. Oil system jets (10)

l. Chip detector/temperature switch

m. Temperature transducer

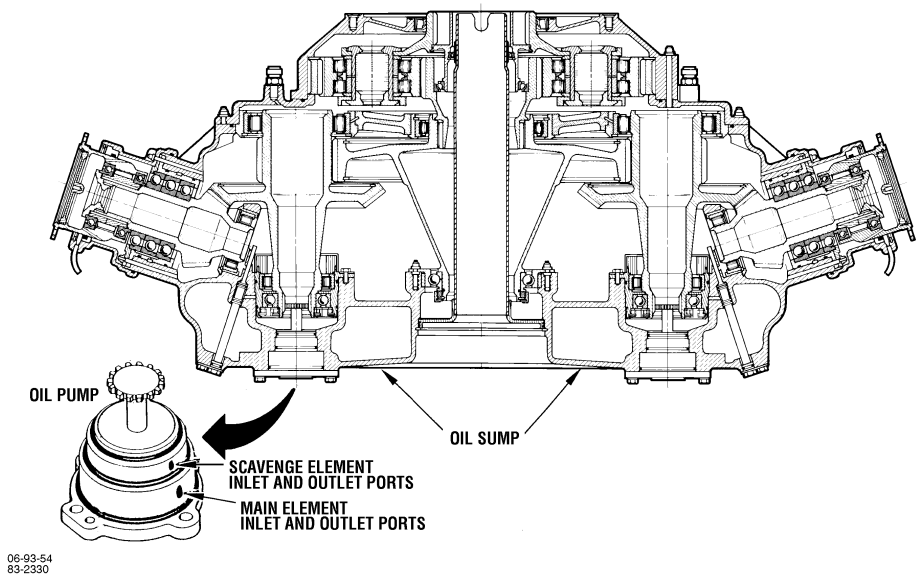
n. Oil level sight plug

o. Float diverter valve

p. Oil filler

071-(

OIL SUMP AND OIL PUMP



NOTES

3. Oil sump (2)

    a. Contains the primary oil subsystem lubrication oil.

    b. Makes up the bottom section of the main transmission housing.

    c. Contains one oil entry port around the diverter valve.

    d. An interconnecting port is located between both oil sumps.

4. Oil pump (2)

    a. Pressurizes the oil subsystem and lubricates the primary geartrain.

    b. Scavenges oil from the accessory gear train housing assembly internal oil passages and pumps it out to the "false" floor of the main transmission (top of the oil sump).

    c. Installed on the bottom of the oil sump.

    d. A two element gerotor type oil pump.

    e. Driven by the intermediate stage cluster gear.

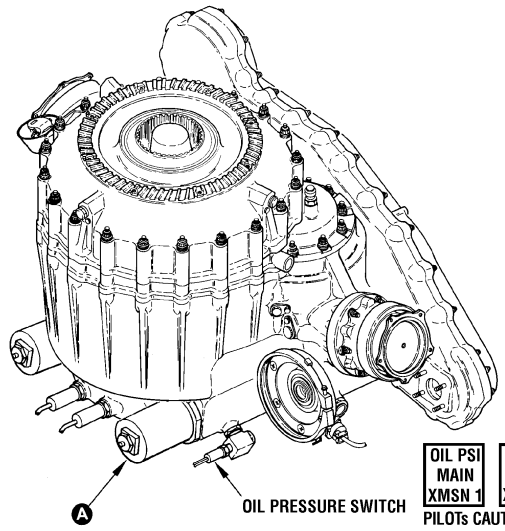
    f. Lower section contains the pump element.

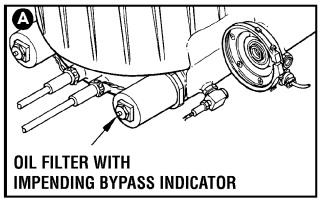
    g. The pump element is rated at 6.5 gpm "0.25 gpm (24.6 ".95 LPM) at 75 psi (517 kPa) at 4391 RPM.

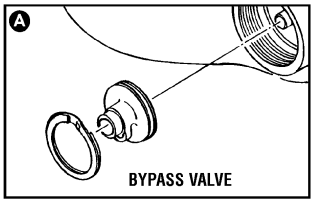
    h. The upper section contains the scavenge inlet and outlet ports.

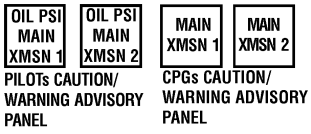
    i. Scavenge element accepts oil at 2 gpm (7.6 LPM), has outlet pressure of 50 psig (344 kPa) at 4391 RPM.

OIL FILTER WITH IMPENDING BYPASS INDICATOR, BYPASS VALVE, AND OIL PRESSURE SWITCH









06-93-55
06-91-02

NOTES

5. Oil filter with impending bypass indicator and bypass valve (2)

   a. Removes impurities from the oil, visually indicates a partially clogged oil filter, and bypasses oil around the filter when required.

   b. Located on the lower part of the main transmission front face.

   c. Components

      (1) 12 micron disposable paper filter - installed inside the filter bowl.

      (2) Impending bypass indicator - installed on top of the filter bowl.

         (a) Pops out when differential pressure across the filter is greater than 23 "2 psid (158 "13.7 kPa).

         (b) The impending bypass indicator can be reset.

      (3) An oil bypass valve located on the housing below the oil filter allows oil to bypass the oil filter when valve cracking pressure of 38 "4 psid (262 "27.6 kPa) is reached.

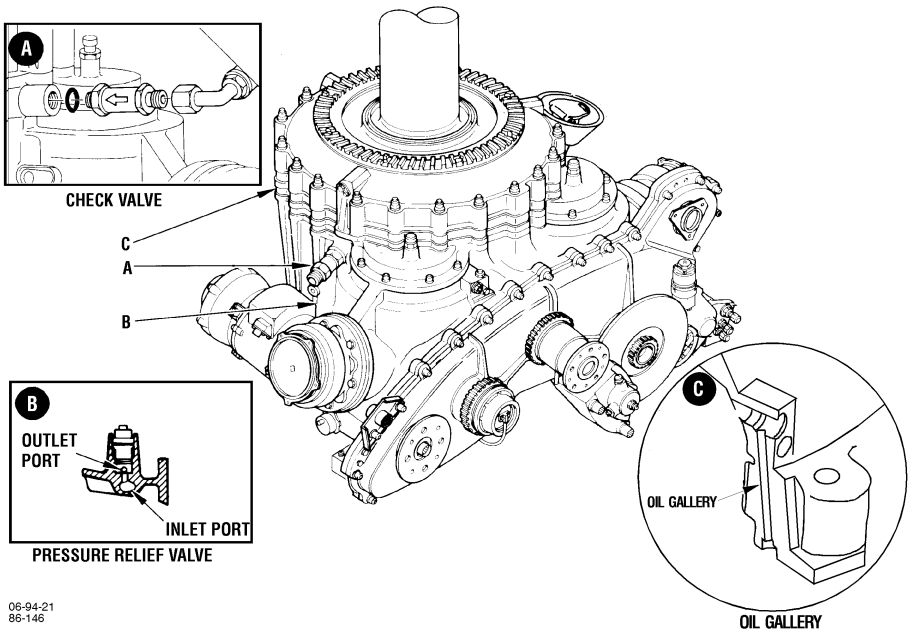
6. Oil pressure switch (2)

   a. Monitors the subsystem oil pressure.

   b. Mounted on the output "T" fitting on the lower side of the oil sump.

   c. Illuminates the pilot's OIL PSI MAIN XMSN 1 or 2 caution light and the CPG's MAIN XMSN 1 or 2 caution light when pressure drops to 28 "2 psi (193 "13.8 kPa). Caution light goes out when pressure reaches 45 psi (310 kPa).

CHECK VALVE, PRESSURE RELIEF VALVE AND OIL GALLERY



NOTES

7. Check valve (2)

    a. Prevents oil from escaping from the main transmission after an external oil line or component suffers an oil leak.

    b. Installed on the oil return line entry into the main transmission oil gallery.

    c. The one-way check valve closes when input oil pressure drops, thereby blocking the oil inside the oil gallery.

8. Pressure relief valve (2)

    a. Channels excess oil from the oil gallery back into the transmission housing.

    b. Valve is internally installed in the transmission housing and is only accessible at depot.

    c. Receives oil from the oil gallery, 3.9 gpm (14.8 LPM) at 51.1 psig (352 kPa), with a maximum of 7.5 gpm (28.4 LPM), and returns it to the oil sump.

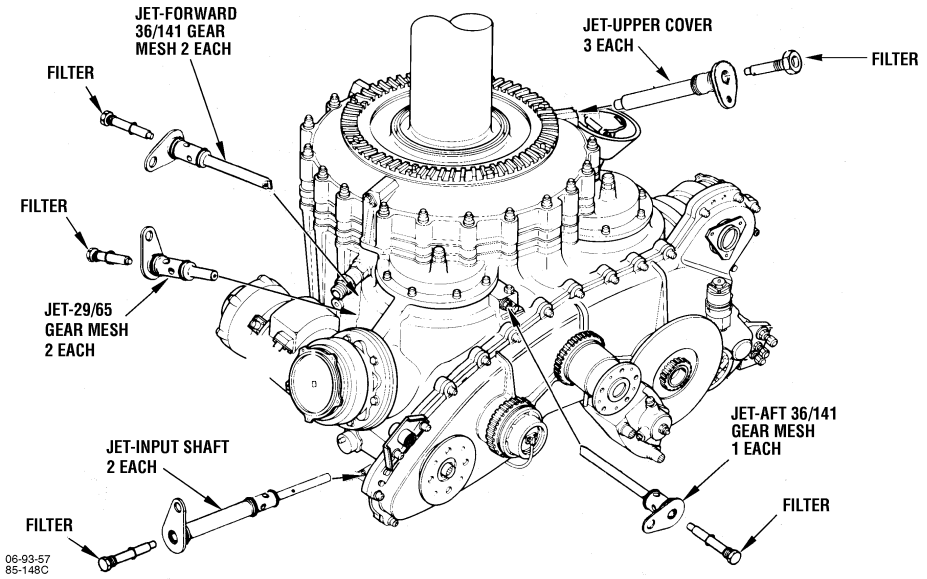
9. Oil gallery

    a. Accepts oil from both primary oil subsystems and diverts the oil to lubricate the main transmission assembly primary gear train.

    b. Internal oil passage inside the main transmission and intermediate support housings.

    c. Intakes approximately 13 gpm (49.2 LPM). Funnels 6.5 gpm (24.6 LPM) to the external oil jets and 6.5 gpm (24.6 LPM) to the pressure relief valves.

FILTER OIL JETS (10)



NOTES

10. Oil system jets

    a. Sprays filtered oil directly on the components requiring lubrication.

    b. Installed externally in strategic locations on the transmission housing assembly.

    c. Ten filtered oil jets are installed.

        (1) Three jets lubricate the planetary gear assembly and oil wicking disks.

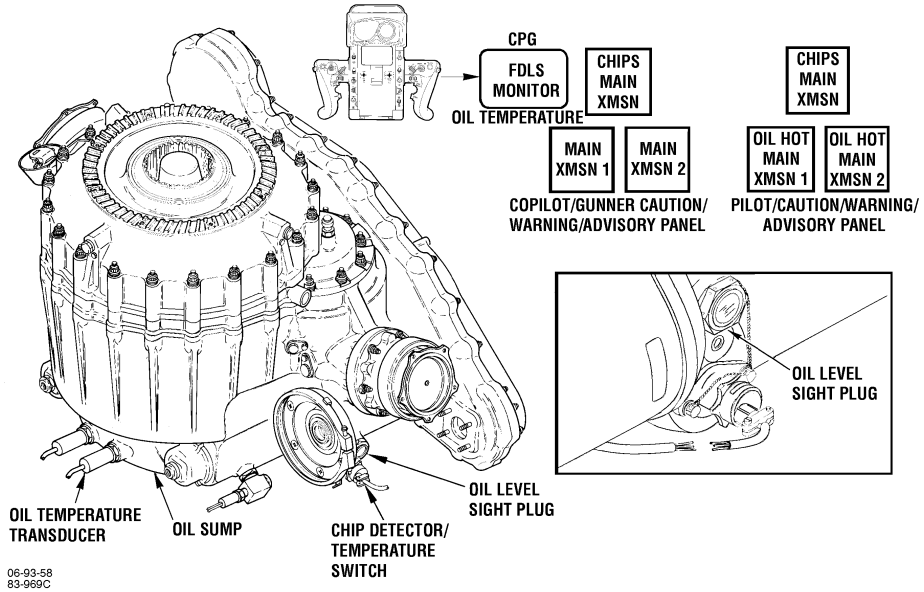
        (2) Three jets lubricate the intermediate stage cluster gears and intermediate helical cluster gear mesh.

        (3) Two jets lubricate the intermediate stage cluster gear and input bevel pinion gear mesh.

        (4) Two jets lubricate the input shaft and the intermediate stage cluster gear support bearings.

    d. The jet's oil filter element is a 0.010 inch (0.0254 cm) filter screen.

CHIP DETECTOR/TEMPERATURE SWITCH, OIL TEMPERATURE TRANSDUCER, AND OIL LEVEL SIGHT PLUG



NOTES

11. Chip detector/temperature switch (2)

    a. Warns of metal particles in the oil system.

    b. Burns off small metal particles (fuzz).

    c. Monitors the oil temperature in the sump.

    d. Installed on each side of the lower main transmission housing, below the oil level sight plugs.

    e. A capacitor housed in the body of the chip detector discharges to burn off (fuzz suppression) any accumulation of small metal particles (ferromagnetic material) without turning on the caution lights.

    f. Large metal particles attracted to the chip detector cause the CHIPS MAIN XMSN caution lights in the pilot's and CPG's station to come on.

    g. The temperature switches cause the pilot's OIL HOT MAIN XMSN 1 or 2 and the CPG's MAIN XMSN 1 or 2 caution lights to come on when the oil temperature is 274E - 294EF (134E - 145EC) increasing.

    h. The temperature switches turn off the pilot's OIL HOT MAIN XMSN 1 or 2 and the CPG's MAIN XMSN 1 or 2 caution lights when the oil temperature is 264E - 244EF (128E - 117EC) decreasing.

12. Oil temperature transducer (2)

    a. Provides a means of monitoring the operating temperature of the main transmission assembly.

    b. Mounted on the forward portion of the oil sump.

    c. Transmits a true temperature reading to the Fault Detection/Location System (FD/LS). Display may be viewed by selecting maintenance FD/LS test number 19.

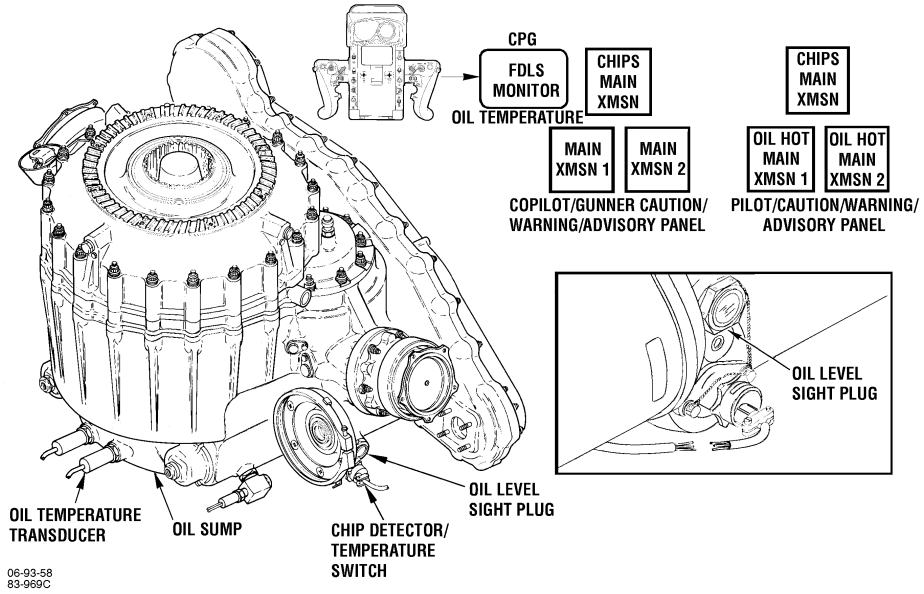
    d. Receives 28 VDC operating voltage from the emergency DC bus through the engine start circuit breaker.

    e. Supplies 0-10 VDC to DASE computer located in the aft avionics bay. This signal is directly monitored by the FD/LS.

13. Oil level sight plug (2)

    a. Provides a means to visually inspect the quantity of oil in the sumps.

CHIP DETECTOR/TEMPERATURE SWITCH, OIL TEMPERATURE TRANSDUCER, AND OIL LEVEL SIGHT PLUG



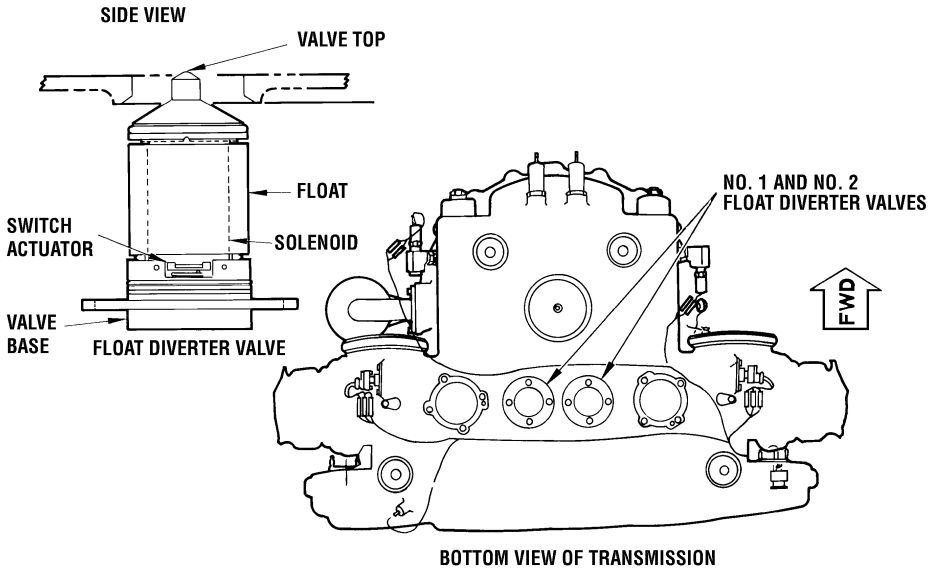
NOTES

b. Installed on the right and left sides of the oil sump.

c. The "bull's-eye" type indicator gives a better view of oil quantity than the flat type.

071-(

NO. 1 AND NO. 2 FLOAT DIVERTER VALVES



NOTES

14. Float diverter valve (1 & 2)

a. Closes off the oil sump, preventing complete loss of oil, in case of a ballistic impact to the sump.

b. Installed in the bottom center of the main transmission.

c. The float diverter valves are identical and contain the following.

(1) Valve

(2) Float

(3) 28 VDC switch

(4) Solenoid

d. When the oil level in the sump drops, the float comes down and closes the 28 VDC switch.

e. When the 28 VDC switch closes, power is supplied to the solenoid.

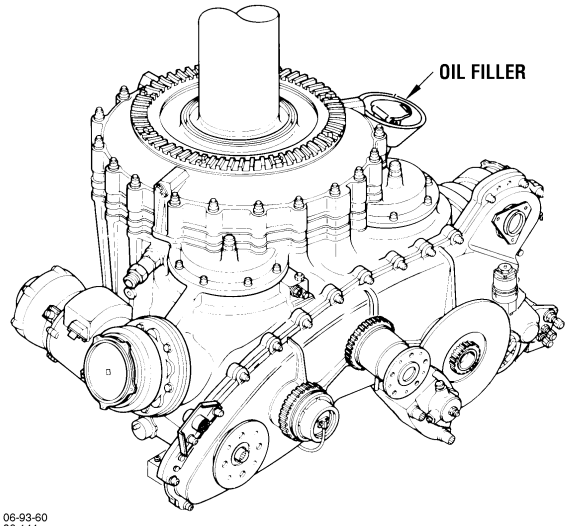
f. When the solenoid is energized, it forces the valve up and close off that sump.

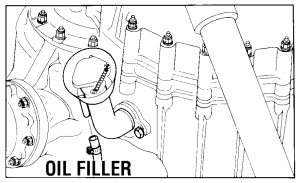
g. Electrical circuitry of the float diverter valve solenoids will not allow both diverter valves to close at the same time. In the event both diverter valves attempt to close, the electrical circuitry will open both valves.

h. Engineering Change Proposal 826 directed that the right-hand diverter valve be disconnected at connector P755, capped and stowed for future installation. This came as a result of a low-pressure warning indication for the main transmission accessory section during aircraft maneuvers at zero or negative "G". A redesign was found to be necessary with regard to the main transmission sump transfer hole. This ECP is canceled upon incorporation of ECP 964.

i. Engineering Change Proposal 964 has resulted in the enlargement of the main transmission housing casting oil sump transfer hole in the horizontal dimension. This oil sump transfer hole has been elongated (enlarged) from its original size of .62 inches to a dimension of 2.25 ".06 inches. This permits better oil flow between the two sumps during those situations that may cause a low oil level/low pressure situation due to the activation of the right-hand diverter valve and a resultant loss of oil delivery to the accessory gearbox. During operation of the aircraft at zero or negative "G" maneuvers, the right-hand diverter valve has, on numerous occasions, activated and closed the right-hand sump, thus causing a low oil pressure situation in the accessory gearbox of the main transmission assembly. The enlargement of the main transmission casting oil sump transfer hole allows for migration of oil through the transfer hole from the left to the right sump.

OIL FILLER





06-93-60
86-144

NOTES

15. Main transmission oil filler

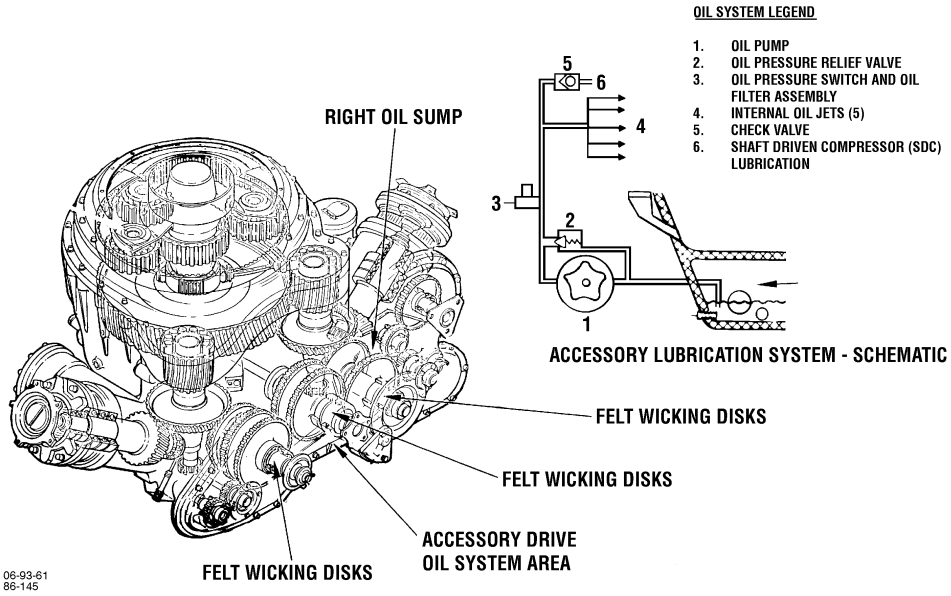
    a. Provides the means for servicing the main transmission assembly.

    b. Installed on the right side of the main transmission assembly.

    c. The oil filler incorporates a spring loaded dust cap to keep out contaminants and a scupper drain for fluid spillage.

071-(

ACCESSORY LUBRICATION SYSTEM



NOTES

P. Accessory lubrication system

1. Provides oil for the accessory geartrain and components during normal transmission operations and during APU ground operations.

2. Installed in the accessory geartrain housing assembly.

3. Draws oil from the right oil sump.

4. Contains oil saturated felt wicking devices inside beveled gears and around helical gears. Centrifugal force provides oil from the saturated wicking devices to lubricate gears, bearings, and other components for a minimum of thirty minutes during emergency operations.

5. When the main transmission is operating, the scavenge pumps return the oil to the sumps. When only the accessory section is operating, oil is returned to the sumps through drain holes located above the over running clutches at the rotor brake and magnetic pickup areas.

6. Accessory lubrication system components

   a. Oil pump

   b. Oil pressure relief valve

   c. Oil filter assembly

   d. Oil pressure switch

   e. Internal oil jets (5)

   f. Shaft driven compressor check valve

7. Main transmission lip seal improvement

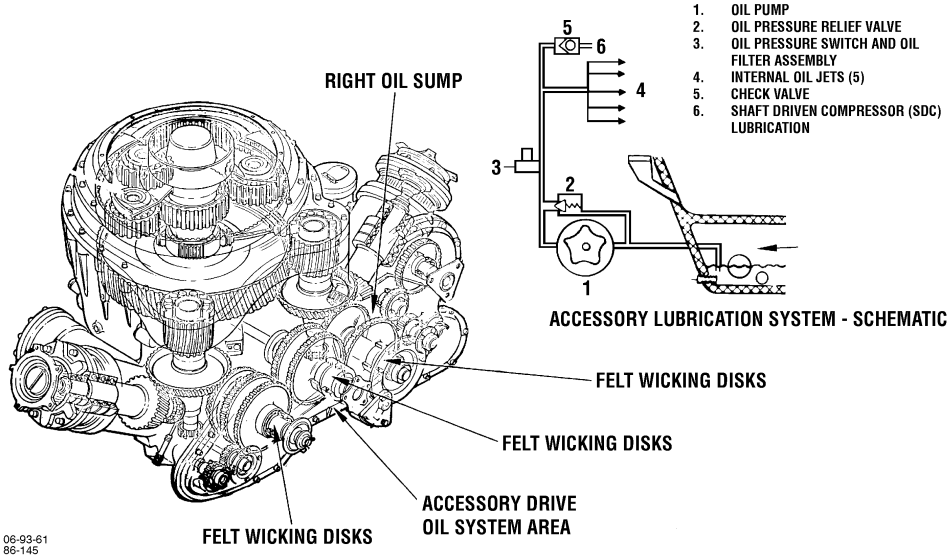
   a. ECP 1271 creates a new lip seal configuration to be used in the main transmission for the two hydraulic pump drives, SDC drive, and APU drive.

   b. Improved seal technology is available and is considered a product improvement. Improved seals reduce the frequency of field removals and replacements.

   c. The new seals are color coded since their effectiveness is direction-of-rotation dependant.

      (1) The new seals for the shaft driven compressor and both hydraulic pumps are P/N 7-1131008-3 and are color coded brown to indicate sealing for clockwise rotation.

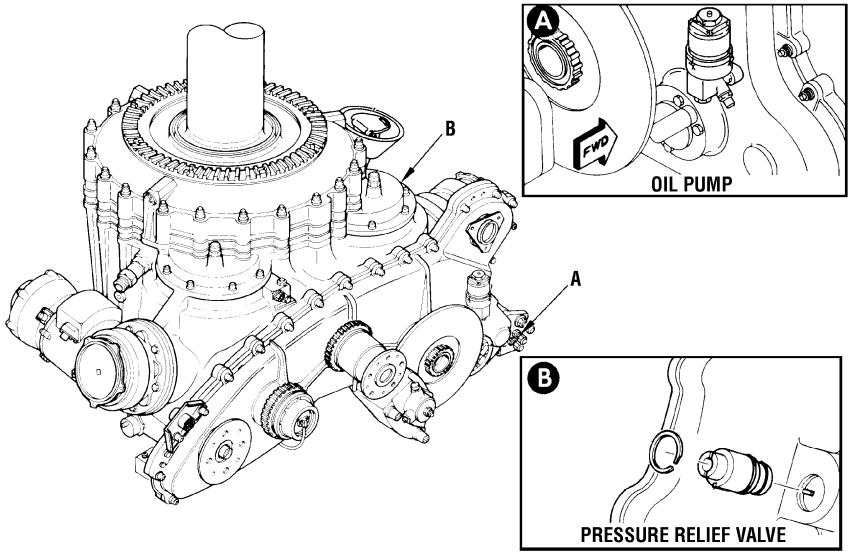
ACCESSORY LUBRICATION SYSTEM



NOTES

(2) The new seal for the #7 drive shaft (APU) is P/N 7-1131008-5 and is color coded black to indicate sealing in a counterclockwise rotation.

ACCESSORY OIL PUMP AND PRESSURE RELIEF VALVE



NOTES

Q. Accessory lubrication system component description

1. Oil pump

   a. Pressurizes the system and lubricates the accessory housing assembly components.

   b. Mounted on the right side of the accessory geartrain housing assembly.

   c. Gerotor type oil pump is driven by the right generator spur gear.

   d. Rated at 1.5 "0.3 gpm (5.7 "1.13 LPM), 100 psig (689 kPa) at 12,251 rpm.

2. Pressure relief valve

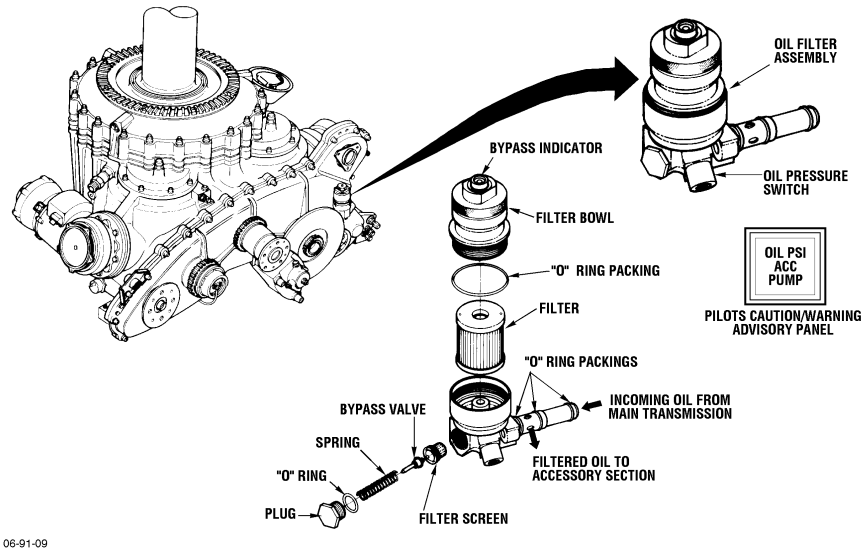
   a. Controls oil pressure in the accessory oil system.

   b. Installed on the main transmission housing aft of the right input housing assembly.

   c. Cracks open at 130 psig (896 kPa) and with full flow of 1.5 gpm (5.7 LPM) at 145 psig (1000 kPa).

   d. Reseats at 100 psig (689 kPa).

ACCESSORY OIL PRESSURE SWITCH AND OIL FILTER ASSEMBLY



NOTES

3. Oil pressure switch

   a. Monitors the accessory oil system during geartrain operations.

   b. Installed on the accessory oil filter assembly to the right and above the oil pump.

   c. The accessory drive oil pressure switch:

      (1) Turns off the pilot's OIL PSI ACC PUMP caution light when oil pressure is 45 psi (310 kPa) increasing.

      (2) Turns on the pilot's OIL PSI ACC PUMP caution light when oil pressure is 30-26 psig (207-179 kPa) decreasing.

4. Oil filter assembly

   a. Removes contaminants from the transmission accessory oil system.

   b. Bypasses oil around the filter element if it becomes clogged.

   c. Mounted on the right side of the accessory section, slightly above and to the right of the accessory oil pump.

   d. Consists of two filter elements.

      (1) The main filter is a disposable element rated at 10 microns nominal and 25 microns absolute.

      (2) The main filter, housed in a bowl, has a differential pressure indicator (impending bypass) on top of the bowl.

      (3) The indicator pops out when the differential pressure across the filter is 20 "3 psid (138 "20.7 kPa).

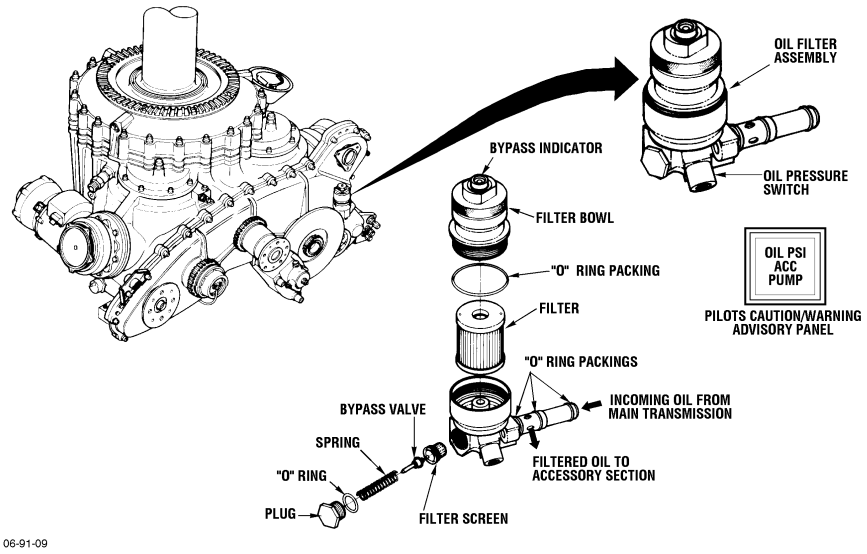
      (4) The impending bypass indicator can be reset.

      (5) The main filter assembly contains an oil bypass valve which allows oil to bypass the filter element when a differential pressure of 30 "5 psid (206 "34.5 kPa) is reached.

      (6) A cleanable filter element (screen) is located downstream from the main element. It is rated at 250 microns nominal.

   e. Modification work order (MWO) 1-1615-238-55-01

ACCESSORY OIL PRESSURE SWITCH AND OIL FILTER ASSEMBLY



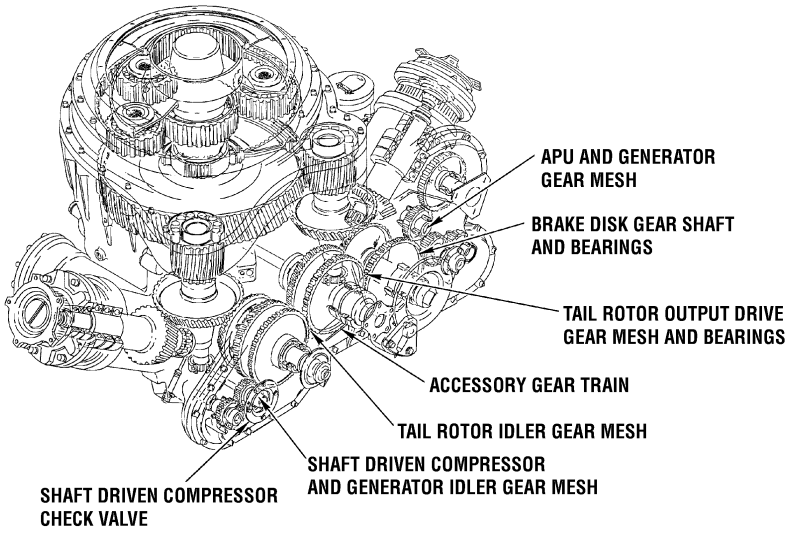
NOTES

(1) Changes the design of the accessory oil filter. The new design precludes contaminates trapped within the filter from being carried downstream while the filter is in bypass.

(2) Incorporates a delay device for the bypass indicator.

(3) The delay device prevents false triggering of the by-pass indicator due to cold oil viscosity at transmission start-up.

ACCESSORY LUBRICATION SYSTEM
INTERNAL LUBRICATION AREAS



NOTES

5. Internal oil jets

   a. Spray filtered oil to lubricate gears, bearings, wicking devices, and other components.

   b. Found internally at strategic lubrication points.

   c. Five internal oil jets lubricate:

      (1) The APU drive and generator idle gear mesh.

      (2) The rotor brake disk output gear shaft and bearings.

      (3) The tail rotor output drive gear mesh and bearings.

      (4) The tail rotor idler gear mesh.

      (5) Shaft driven compressor and generator idler gear mesh.

6. SDC check valve

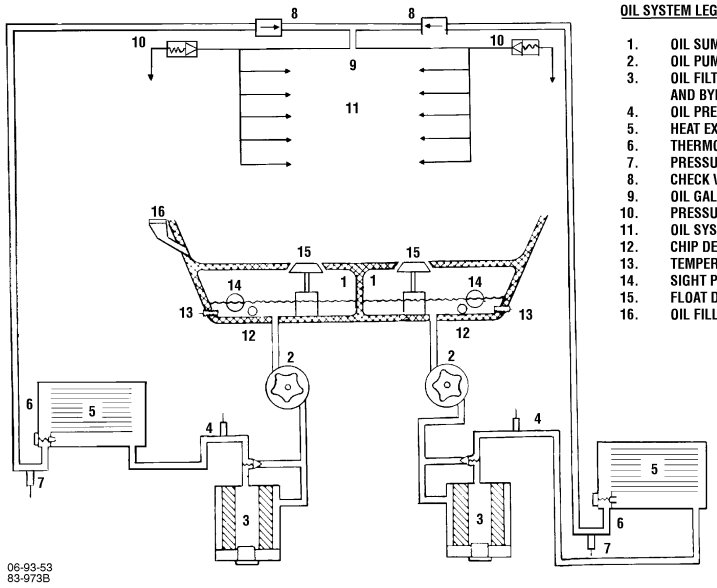
   a. The one-way SDC oil check valve prevents back-flow of SDC oil into the accessory gearbox.

   b. It opens at 2 to 4 psig (13.7 - 27.6 kPa).

   c. This valve additionally prevents oil from leaking out of the accessory gearbox while the SDC is being removed.

071-(

DUAL LUBRICATION SYSTEM



OIL SYSTEM LEGEND

1. OIL SUMP (2)
2. OIL PUMP (2)
3. OIL FILTER (2) WITH IMPENDING BYPASS INDICATOR AND BYPASS VALVE
4. OIL PRESSURE SWITCH (2)
5. HEAT EXCHANGER (2)
6. THERMOSTATIC BYPASS VALVE (2)
7. PRESSURE TRANSDUCER (2)
8. CHECK VALVE (2)
9. OIL GALLERY
10. PRESSURE RELIEF VALVE
11. OIL SYSTEM JETS (10)
12. CHIP DETECTOR/TEMPERATURE SWITCH (2)
13. TEMPERATURE TRANSDUCER (2)
14. SIGHT PLUG (2)
15. FLOAT DIVERTER VALVE (2)
16. OIL FILLER

NOTES

R. Main transmission lubrication system operation

1. The transmission oil system supplies pressurized, filtered, and cooled oil to the transmission bearings and using components.

2. The sumps hold 45 pints.

3. From the sump, oil is suctioned by the pump to be pressurized. The oil is then routed to the forward area of the sumps where it is filtered before being sent through the system.

4. An oil pressure switch (installed in each "T" fitting where oil exits the filter and sump case) senses oil pressure leaving the filter.

5. After being "sensed" by the oil pressure switch, oil is routed through hoses to the heat exchangers. The heat exchangers are both pressure and thermostatically controlled.

   a. Oil with a temperature below 110E to 120EF (43E-48EC) is diverted around the exchanger core to provide faster warm-up.

   b. When differential pressure across the core exceeds 25 PSID, oil is routed around the clogged core.

6. Oil leaving the heat exchanger is sensed for pressure by a pressure transducer. The pressure transducers send a signal to FD/LS for exact pressure readouts.

7. From the transducer, oil returns through hoses to the check valves installed in the support case.

   a. If one of the two oil systems fails, the other oil system can supply all the oil necessary for transmission operation.

   b. The check valves prevent the operational system's oil from being transferred to the malfunctioning system.

8. From the check valves, oil is directed to the oil jets. There are 10 jets that supply oil to the internal bearings and gear-meshes.

9. Excessive oil pressure and flow is relieved by flow/relief valves. These valves are installed in the oil gallery (not the sumps) downstream of the oil jets. This ensures a positive oil supply to each of the oil jets.

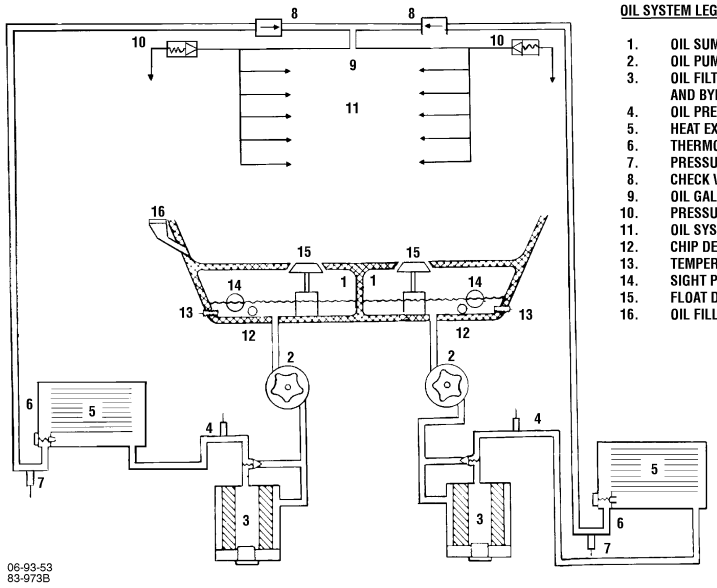
10. After lubricating the bearings and gear-meshes, oil drains to the sumps.

11. In the sumps, the oil is sensed for metallic particles and temperature.

    a. The chip detector/temperature sensors illuminate the CHIPS MAIN XMSN or the respective OIL HOT MAIN XMSN 1 or 2 caution light s as appropriate.

071-(

DUAL LUBRICATION SYSTEM



OIL SYSTEM LEGEND

1. OIL SUMP (2)
2. OIL PUMP (2)
3. OIL FILTER (2) WITH IMPENDING BYPASS INDICATOR AND BYPASS VALVE
4. OIL PRESSURE SWITCH (2)
5. HEAT EXCHANGER (2)
6. THERMOSTATIC BYPASS VALVE (2)
7. PRESSURE TRANSDUCER (2)
8. CHECK VALVE (2)
9. OIL GALLERY
10. PRESSURE RELIEF VALVE
11. OIL SYSTEM JETS (10)
12. CHIP DETECTOR/TEMPERATURE SWITCH (2)
13. TEMPERATURE TRANSDUCER (2)
14. SIGHT PLUG (2)
15. FLOAT DIVERTER VALVE (2)
16. OIL FILLER

NOTES

b. The oil temperature transducers send a signal to FD/LS for exact temperature readouts.

12. Oil for the AGB is scavenged from the No. 2 oil sump by the AGB oil pump. The oil is pressurized and routed to the AGB oil filter assembly where impurities are removed. (The AGB has a separate filter because the oil scavenged from the No. 2 oil sump does not go through the main transmission filters).

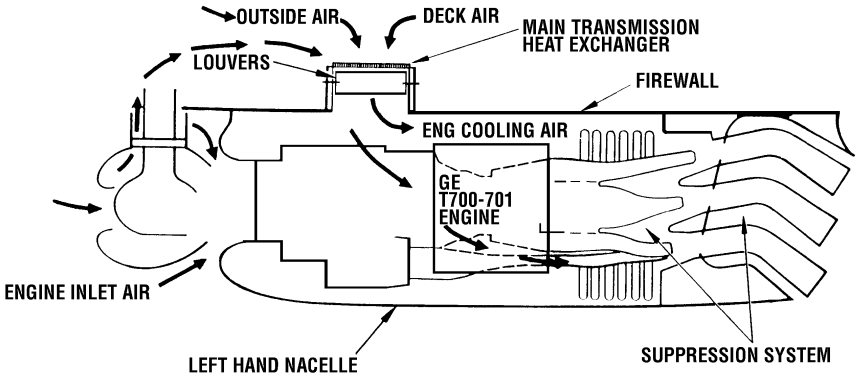
13. A pressure switch on the filter body senses oil pressure. The switch causes the OIL PSI ACC PUMP caution light to extinguish at 45 PSI increasing and illuminate at 26 - 30 PSI decreasing.

14. After passing through the filter and pressure switch, the oil is routed through internal passages to 5 internal oil jets that spray filtered oil to lubricate gears, bearings, wicking devices, and other components.

15. If only the APU is operating, return oil to the AGB does not go through a cooling cycle. The main transmission oil pumps must be operating in order to scavenge oil back into the system and out to the heat exchangers.

071-(

TRANSMISSION OIL COOLING



06-93-63
83-708A

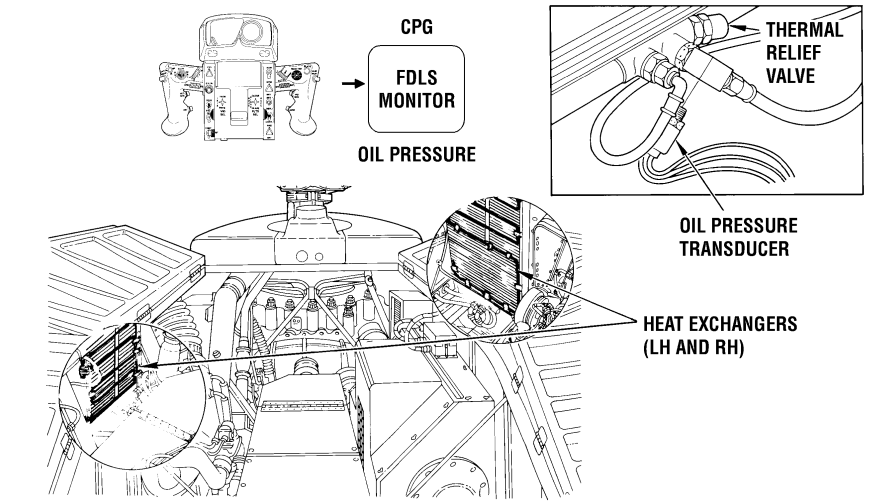
NOTES

S. Main transmission cooling

1. Maintains the main transmission assembly within the temperature requirements for normal operations.

2. Cooling air from the rotor down-wash and the engine nose gearbox cooling fan flow around the main transmission to aid in cooling.

HEAT EXCHANGERS AND OIL PRESSURE TRANSDUCERS



NOTES

3. Transmission oil is cooled by the heat exchangers.

4. A thermal relief valve and pressure transducer are incorporated on the heat exchangers.

   a. Heat exchangers

      (1) Cool the main transmission oil.

      (2) Mounted inboard of each engine firewall.

      (3) Radiator-type heat exchanger allows cooling air to flow around the cooling cores to cool the oil.

      (4) The air is expelled along with the engine exhaust system air.

   b. Thermal relief valve

      (1) Allows oil to bypass the heat exchanger cooling cores until the oil reaches operating temperature of 110E to 120EF (43E- 48EC).

      (2) Installed internally on the bottom of the heat exchanger.

      (3) Automatically opens after shutdown as the oil cools.

   c. Pressure transducer

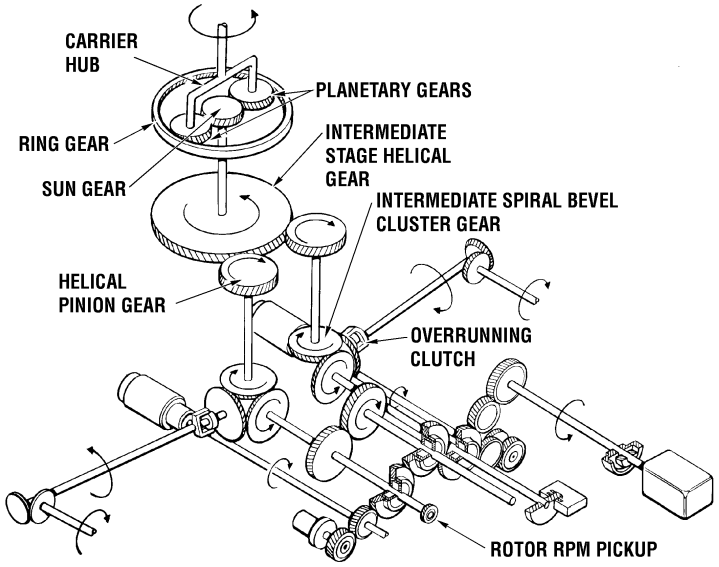
      (1) Transmits a pressure reading to the Fault Detection/Location System (FD/LS).

      (2) Mounted on the oil outlet port on the heat exchanger.

      (3) Receives its operating power of 0-5 VDC from the left and right hand FABs MRTU Type I.

071-(

PRIMARY GEARTRAIN OPERATION



NOTES

T. Primary geartrain operation

1. The main transmission has two input overrunning clutches which allow single engine operation and autorotation during emergency operations.

2. There are three spiral bevel gears in each intermediate cluster gear unit.

3. The cluster gear units provide the first stage of speed reduction and change angle of rotation for primary and accessory drive.

4. The spiral bevel gears and the intermediate helical gear incorporate spirolox dampers which attenuate noise and dampen gear frequencies.

5. The two primary oil pumps are driven by the primary cluster gear shaft.

6. Two helical pinion gears are mounted on a common shaft with the primary cluster gears.

7. The helical pinion gears drive a single intermediate stage helical gear which provide the second stage of speed reduction.

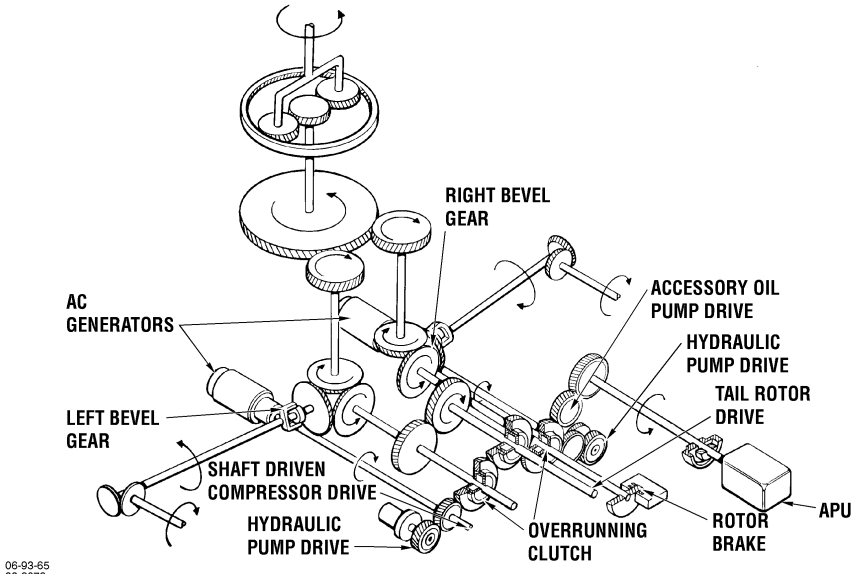
8. The spur sun gear is driven by the intermediate stage helical gear. It drives six planetary spur gears around the inner teeth of the ring gear.

9. The ring gear is splined to the transmission cover and does not rotate.

10. The planetary gears provide the final stage of speed reduction and drive the carrier hub.

11. The carrier hub drives the main rotor drive shaft, which floats within the carrier hub supported on a spring.

ACCESSORY GEARTRAIN OPERATION



NOTES

U. Accessory geartrain operation

1. The accessory geartrain is driven by the transmission when it is operating at 100 percent N_R.

2. Accessory drive is provided by the APU when the transmission is operating below 95 percent N_R.

3. The accessory cluster gears drive accessories through helical gears mounted on the same common shaft.

4. The accessory drive train drives:

   a. Two generators.

   b. The shaft driven compressor.

   c. Two hydraulic pumps.

NOTE: The APU drive shaft continues to rotate when the rotors are turning even if the APU is off. This is because the PTO clutch is installed on the APU side of the drive shaft.

   d. APU input and accessory oil pump on the right side.

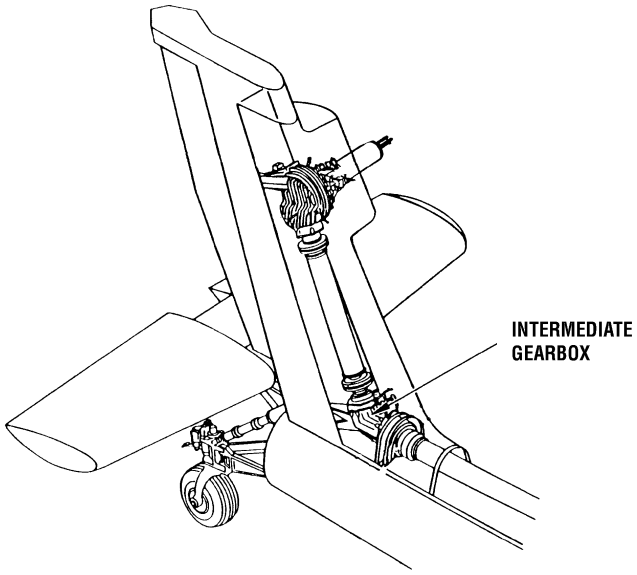
   e. Rotor brake disk.

   f. Tail rotor drive shafts.

5. The magnetic pick-up, rotor brake disk, and tail rotor drive shaft are driven only during main transmission operation.

071-(

INTERMEDIATE GEARBOX ASSEMBLY



06-93-66
83-347A

NOTES

V. Intermediate gearbox (IGB) assembly

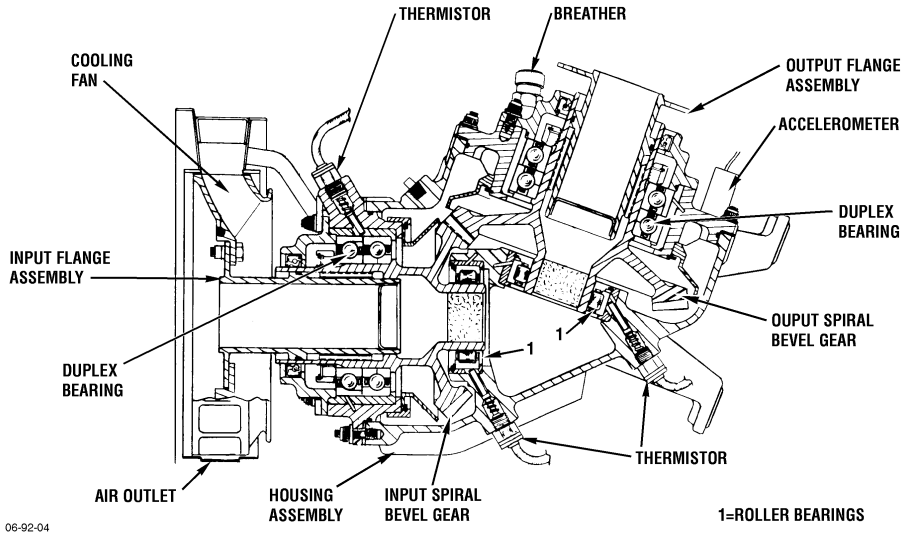
1. Transmits power from the main transmission to the tail rotor gearbox.

2. Changes the angle of drive 71E and reduces speed from 4815 to 3636 rpm.

3. Mounted at the base of the vertical stabilizer.

4. Made of a lightweight magnesium alloy and weighs approximately fifty pounds (22.7 kilograms).

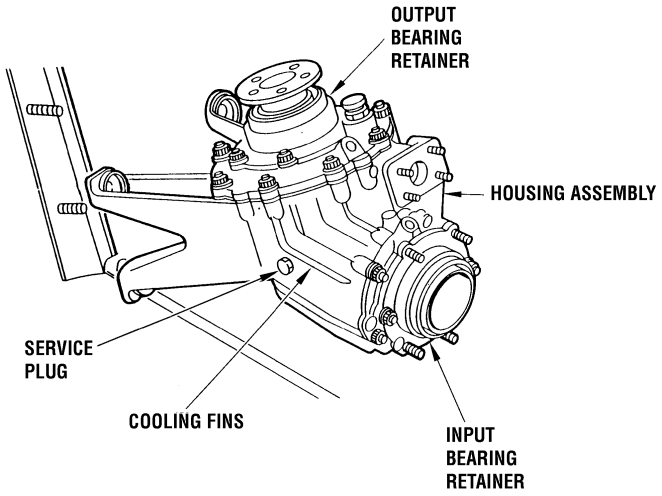
INTERMEDIATE GEARBOX ASSEMBLY MAJOR COMPONENTS



NOTES

5. IGB major components
    a. Housing assembly
    b. Input and output bearing/seal retainer
    c. Input and output spiral bevel gears
    d. Duplex bearings (2)
    e. Roller bearings (2)
    f. Input and output flange assemblies
6. IGB installed components
    a. Thermistors (4)
    b. Accelerometer
    c. Breather vent
    d. Cooling fan

INTERMEDIATE GEARBOX HOUSING ASSEMBLY



83-350C

NOTES

W. Component description

1. Housing assembly

a. Contains and supports the intermediate gearbox components.

b. The housing assembly is completely finned for cooling, and incorporates an input and an output bearing seal retainer.

2. Input and output seal/bearing retainer

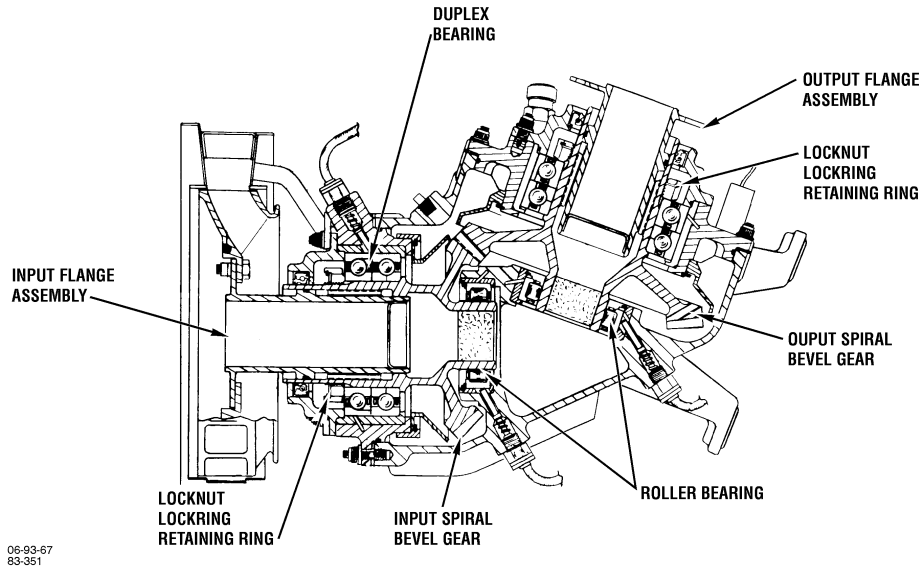
a. Provides support for the input and output seats as well as retains the duplex bearing assembly.

b. Installed over the input and output spiral bevel gear assembly.

c. Supports a carbon/magnetic seal.

d. Constant pressure on the outer race of the duplex bearing assembly prevents rotation within the housing.

INTERMEDIATE GEARBOX INPUT SPIRAL BEVEL GEAR/ OUTPUT SPIRAL BEVEL GEAR



NOTES

3. Input and output spiral bevel gears

    a. The input spiral bevel gear transmits power from the input flange assembly to the output spiral bevel gear.

    b. The output spiral bevel gear transmits reduced RPM from the input spiral bevel gear to the output flange assembly.

    c. The input spiral bevel gear is installed between the input retainer and the output spiral bevel gear.

    d. The output spiral bevel gear is installed between the input spiral bevel gear and the output retainer.

    e. The spiral bevel gears and the flange assemblies are made of steel.

    f. The spiral bevel gears are held in position by a locknut, lock-ring, and retaining ring.

    g. A cork is installed in the hollow shaft to prevent grease from leaking past the flange assemblies.

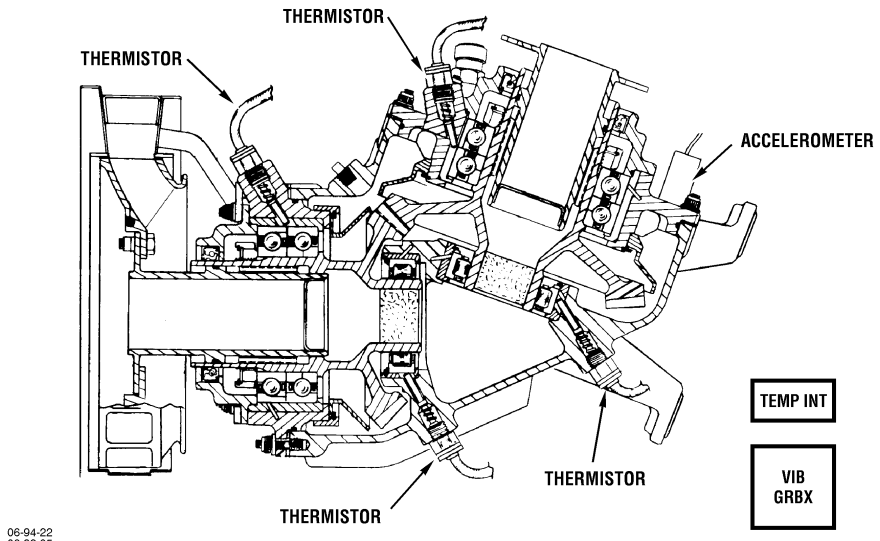
4. Duplex and roller bearings

    a. Duplex bearings - one duplex bearing supports the center section of the input gear and one supports the center section of the output spiral bevel gear.

    b. Roller bearings - one roller bearing supports the spiral end of the input gear and one supports the inner end of the output spiral bevel gear.

5. Input and output flange assemblies - allow drive shaft attachment.

INTERMEDIATE GEARBOX ASSEMBLY CAUTION/WARNING DEVICES



NOTES

6. Thermistors (4)

   a. Monitor the temperature on the duplex bearings and roller bearings.

   b. Four thermistors are installed on the housing assembly.

   c. The thermistor is a coil activated temperature switch spring loaded to maintain a constant contact with the bearing housings.

   d. The four thermistors are connected to a single caution light in each crewstation.

   e. A temperature of 290EF (143EC) turns on the pilot's and the CPG's TEMP INT caution lights.

7. Accelerometer

   a. Monitors vibration inside the intermediate gearbox.

   b. Installed on the upper rear center section of the intermediate gearbox.

   c. Connected to a single caution light in the pilot's and CPG's crewstations.

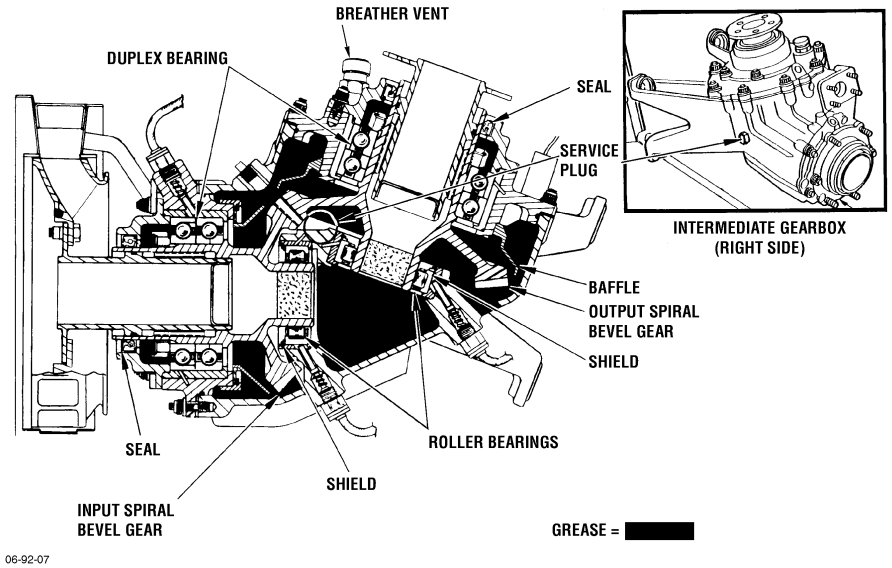
   d. Vibrations sensed by the accelerometer are transmitted to a signal processor located under the CPG's seat. When the signal strength exceeds 0.2 inches per second (IPS), the VIB GRBX caution light in the pilot and CPG stations illuminate.

8. Breather vent

   a. The breather vent prevents over-pressurization inside the intermediate gearbox.

   b. The vent has a screen filter and is installed on top of the housing assembly.

INTERMEDIATE GEARBOX ASSEMBLY LUBRICATION



NOTES

X. IGB lubrication

1. The IGB is lubricated with a special grease (Grease, SYN-TECH, HMS 20-1155, NS 4405 FG).

   a. When cool, the grease has a very thick consistency but when warmed up turns into a thick liquid.

   b. Input and output seals prevent loss of grease when it has changed to a liquid.

   c. Since metal particles do not flow or move about readily in this grease, a chip detector cannot be used to detect metal particles in the grease.

   d. Grease level should be checked after run-up when the grease is warm.

2. The grease aids in IGB cooling by transferring heat from hot inner components to the outer housing assembly where dissipation occurs.

3. The grease provides lubrication during normal gearbox operation, after a rotating gear seal failure, or after a ballistic impact.

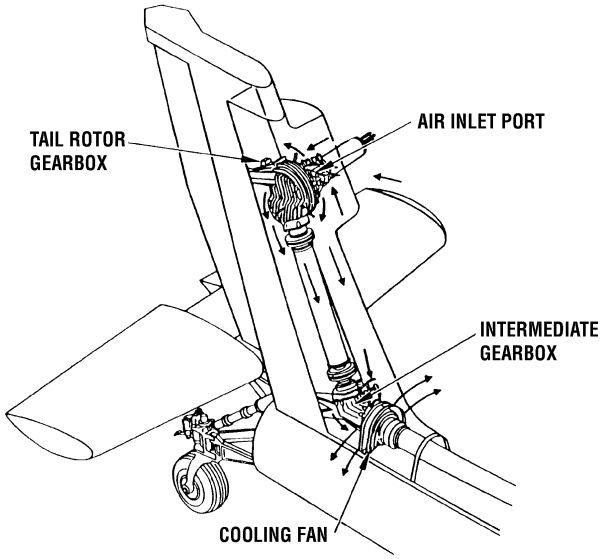
4. Two pounds, two ounces of grease are packed inside the duplex bearings race pockets, the roller bearing race pockets, between bearings, gear mesh, and adjacent cavities.

5. Seals, shields, and baffles retain the grease around the gears and bearings.

6. Servicing with special grease is accomplished through a plug on the right mid-center side of the gearbox.

071-6

INTERMEDIATE GEARBOX COOLING FAN



06-93-68
83-353

NOTES

CAUTION

Prolonged out of ground effect hovering (20 - 30 minutes) with outside air temperatures above 75E F (24E C) may cause the intermediate gearbox to overheat.

Y. IGB cooling

1. The cooling fan and couplings are mounted on the gearbox input flange assembly.

2. Cooling fan rotates at 4815 RPM.

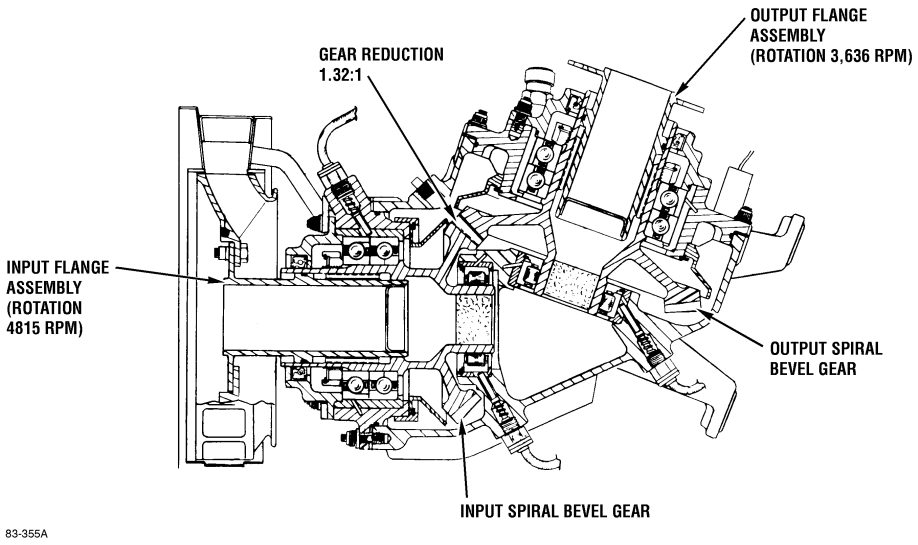
3. Cooling air is provided through the ram air inlet port on the leading edge of the vertical stabilizer.

4. The cooling fan draws air through the inlet port where it passes through the TRGB cooling fins. This air cools the TRGB and maintains the temperature within operating limits.

5. From the TRGB, the air is drawn down the stabilizer where it passes through the IGB cooling fins. This air cools the TRGB and maintains the temperature within operating limits.

6. After cooling the IGB, the air is exhausted out the sides of the diffuser.

INTERMEDIATE GEARBOX FUNCTIONAL DESCRIPTION



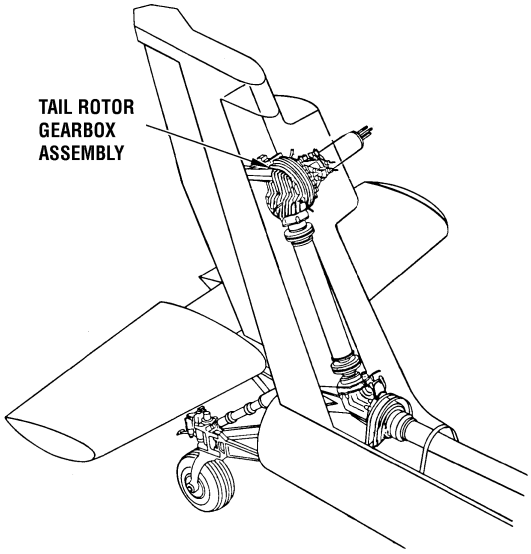
NOTES

Z. IGB operation

1. The intermediate gearbox input flange assembly rotates at 4815 RPM.

2. A gear ratio of 1.32:1 between the input and output spiral bevel gears reduces the speed of the output flange assembly to 3636 RPM.

TAIL ROTOR GEARBOX ASSEMBLY



06-93-69
83-364A

NOTES

AA. Tail rotor gearbox (TRGB) assembly

1. Uses power input from the intermediate gearbox to drive the tail rotor assembly.

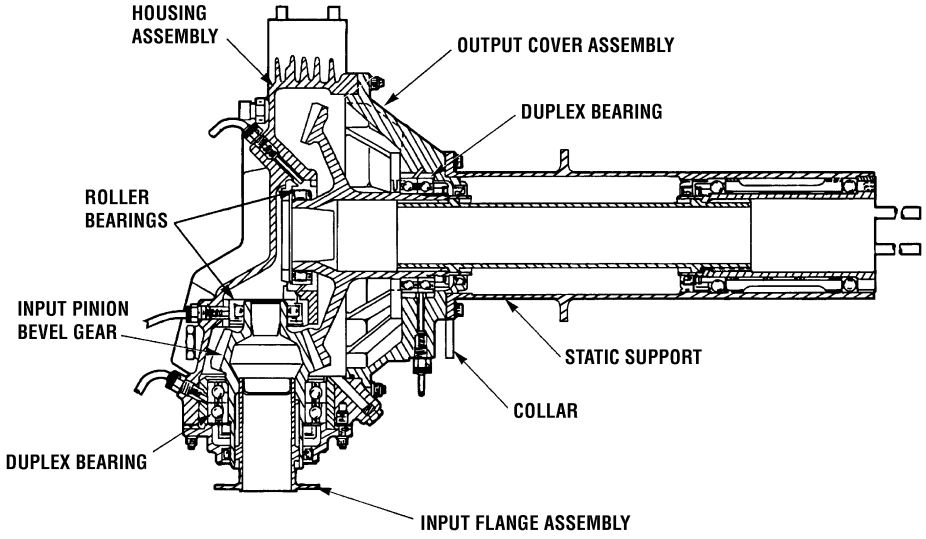
2. Changes the angle of drive 90 degrees and provides a speed reduction.

3. The tail rotor gearbox is mounted on the vertical stabilizer.

4. Round in shape, finned for cooling purposes, and weighs approximately 112 pounds (50.84 kg).

071-(

TAIL ROTOR GEARBOX ASSEMBLY MAJOR COMPONENTS I



NOTES

5. TRGB major components

   a. Housing assembly

   b. Static support

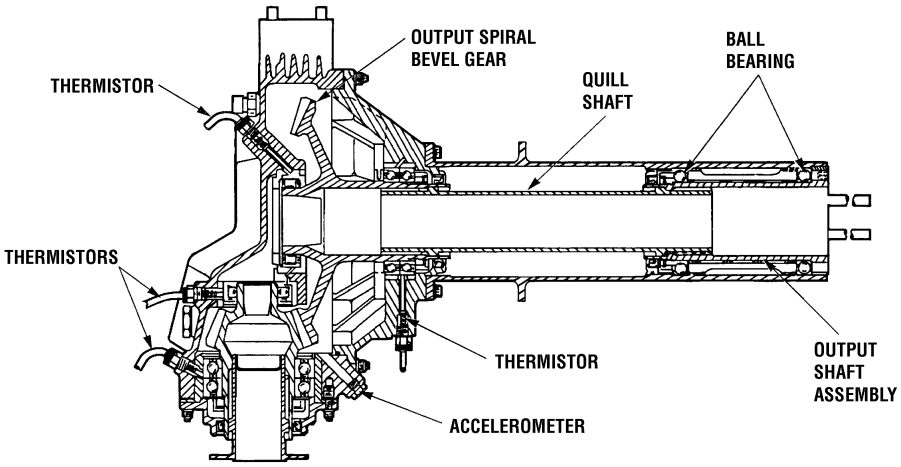
   c. Collar

   d. Input flange assembly/input pinion bevel gear

   e. Duplex bearings

   f. Roller bearings

TAIL ROTOR GEARBOX ASSEMBLY MAJOR COMPONENTS II



06-93-12
83-372A

NOTES

g. Output spiral bevel gear

h. Quill shaft

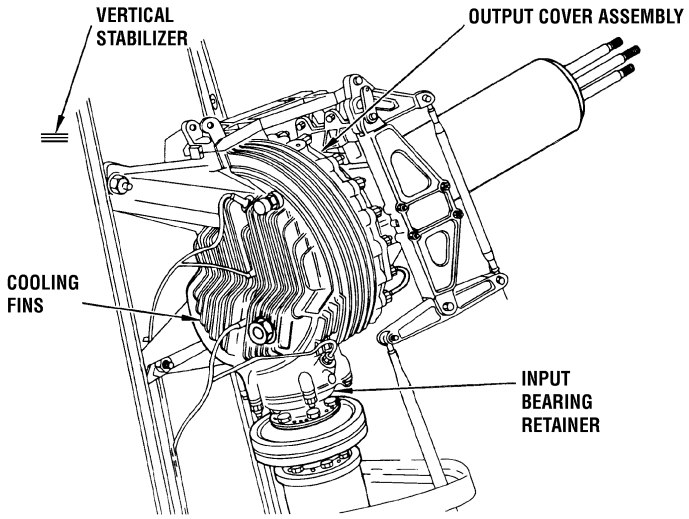
i. Output shaft assembly

j. Ball bearings (2)

k. Thermistors (4)

l. Accelerometer

HOUSING ASSEMBLY



06-93-11

NOTES

6. Component description

a. Housing assembly

b. Houses and supports the tail rotor gearbox components.

c. The housing assembly is made of lightweight magnesium alloy and includes the following components.

(1) Breather vent

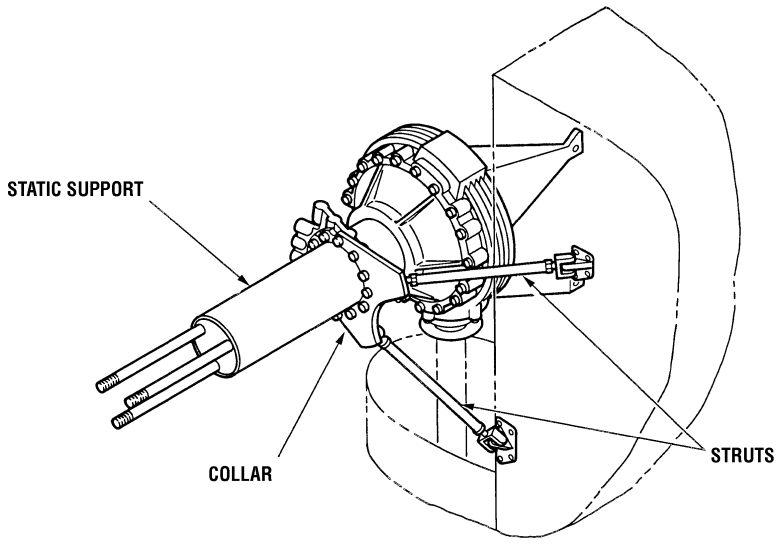
(a) The breather vent located on the upper right hand side of the housing assembly prevents over pressurization inside the tail rotor gearbox.

(b) The vent has a screen filter element.

(2) Input bearing retainer - houses the carbon/magnetic type input seal.

(3) Output cover assembly - houses a duplex bearing set.

STATIC SUPPORT AND COLLAR



NOTES

d. Static support

e. Supports the tail rotor swashplate assembly and the tail rotor assembly.

f. Mounted to the output cover assembly and collar.

g. The static support is made of corrosion resistant steel with an electro polished finish.

h. Transmits all flight loads from the tail rotor to the housing assembly.

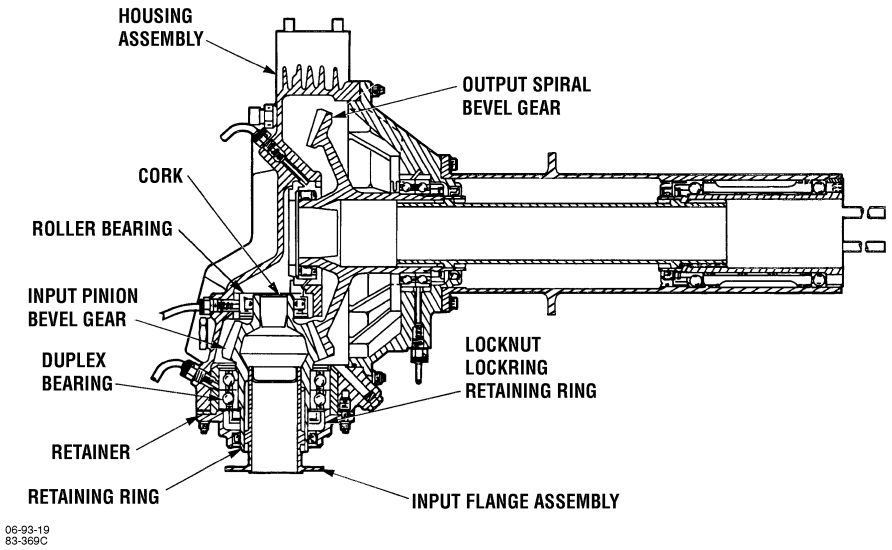
i. Houses a quill shaft, two roller bearings, a grease seal, and output shaft assembly.

7. Collar

a. Supports the static support.

b. Attached to the output cover assembly and supported by two struts bolted to the vertical stabilizer.

INPUT FLANGE ASSEMBLY/ INPUT PINION BEVEL GEAR



NOTES

8. Input flange/pinion bevel gear

    a. Transmits power from the number six drive shaft assembly to the output spiral bevel gear.

    b. The input flange assembly is splined to the input bevel gear and held in place by a retaining ring.

    c. The input bevel gear is installed on the lower end of the housing assembly and held in place by a locknut, lockring, and retaining ring.

    d. A grease retaining cork is installed on the output end of the input pinion bevel gear.

9. Duplex bearing (2)

    a. One supports the center section of the input pinion bevel gear.

    b. The other supports the output end of the output spiral bevel gear.

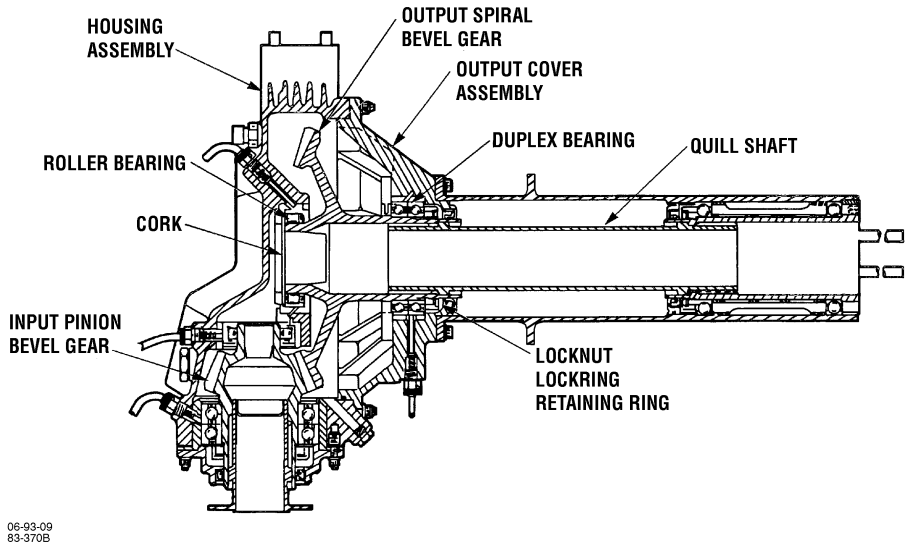
10. Roller bearings (2)

    a. One supports the pinion bevel end of the input gear.

    b. The other supports the spiral end of the output shaft.

071-(

OUTPUT SPIRAL BEVEL GEAR



NOTES

11. Output spiral bevel gear

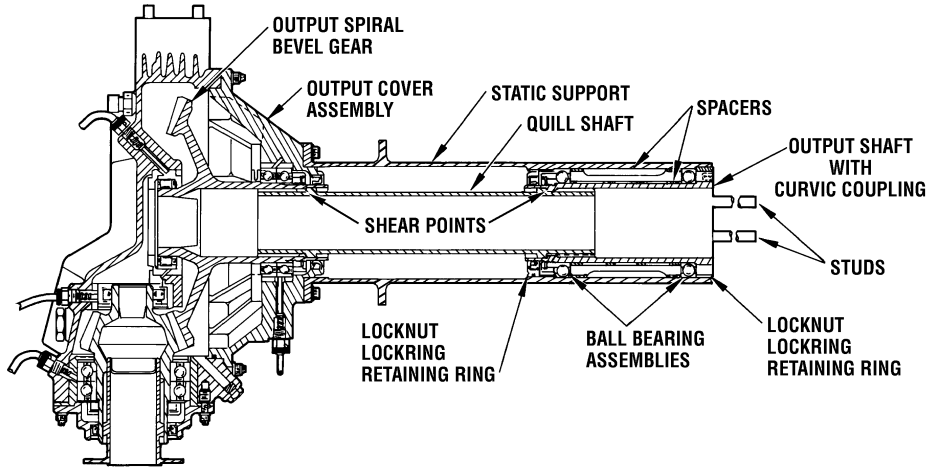
    a. Transmits reduced RPM from the input pinion bevel gear to the quill shaft.

    b. Installed on the output side of the housing assembly and held in place by a locknut, lockring, and retaining ring.

    c. The output end of the spiral bevel gear is splined to accept the quill shaft.

    d. A grease retaining cork is installed on the input end of the output spiral bevel gear.

QUILL SHAFT AND OUTPUT SHAFT ASSEMBLY



NOTES

12. Quill shaft

    a. Transmits power from the output spiral bevel gear to the output shaft assembly.

    b. Installed inside the output cover assembly and static support.

    c. The quill shaft is a solid steel shaft.

    d. The quill shaft is splined at both ends and interconnects with the:

        (1) Output spiral bevel gear.

        (2) Output shaft assembly.

13. Output shaft assembly

    a. Receives power from the quill shaft to drive the tail rotor.

    b. Provides three studs for securing the tail rotor to the tail rotor gearbox.

    c. Installed on the output end of the static support and held in place by two locknuts, two lockrings, and two retaining rings.

    d. A curvic coupling on the output side provides for a positive engagement of the tail rotor.

    e. Two spacers are installed around the output shaft to support the two ball bearing assemblies.

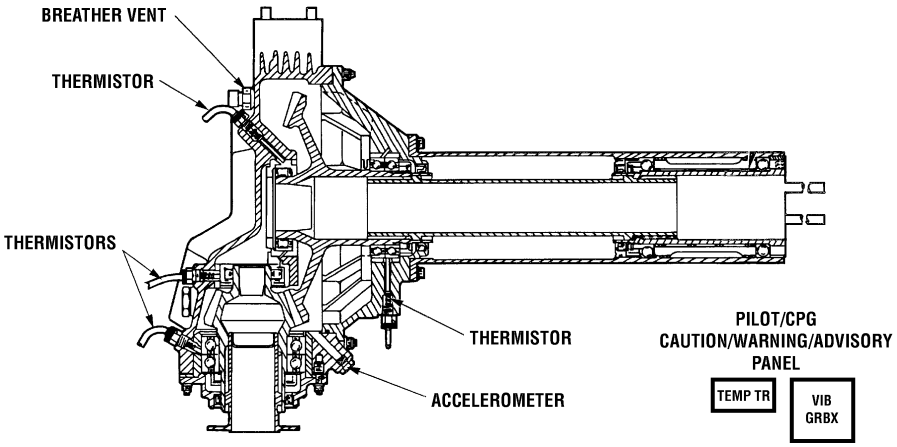
    f. For positive alignment of the tail rotor head, the three studs are positioned at 120E, 125E, and 115E apart.

14. Ball bearings

    a. Support the output shaft assembly.

    b. Positioned on the output side of the static support.

CAUTION/WARNING DEVICES



NOTES

15. Thermistors (4)

    a. Four thermistors are installed to monitor the temperature on the duplex bearings and the roller bearings.

    b. The thermistors are installed on the housing assembly and the output cover assembly.

    c. Each thermistor is a coil activated temperature switch that is spring loaded to maintain a constant contact with the bearing housings.

    d. The four thermistors are connected to a single caution light in each crewstation.

    e. A temperature of 290EF (143EC) increasing turns on the pilot's and the CPG's TEMP TR caution light.

16. Accelerometer

    a. Monitors vibrations inside tail rotor gearbox.

    b. Installed on the lower end of the output cover assembly.

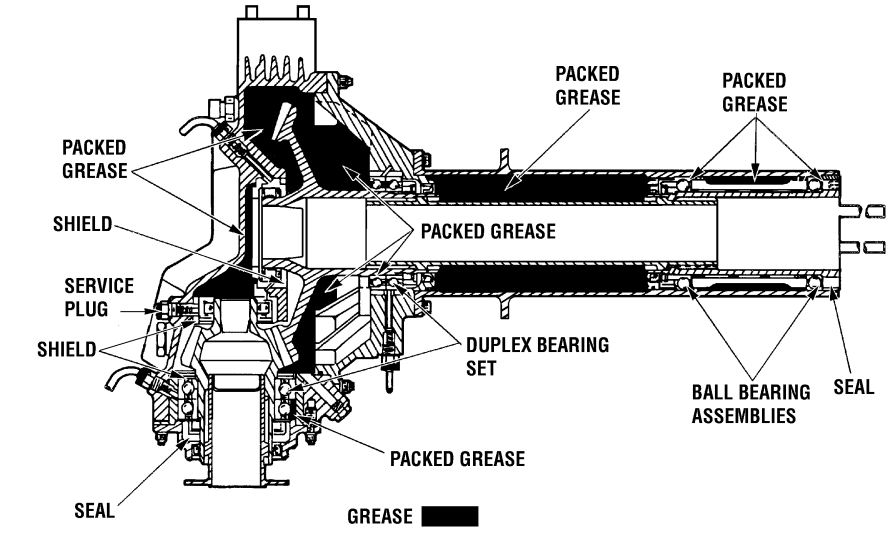
    c. Has a single wire connected to a caution light in the pilot and CPG's station.

    d. Vibrations sensed by the accelerometer are transmitted to a signal process located under the CPG's seat.

    e. Signals received from intermediate gearbox are, in some cases, different from those of the tail rotor gearbox.

071-(

TAIL ROTOR GEARBOX ASSEMBLY LUBRICATION



NOTES

BB. TRGB lubrication

1. The TRGB is lubricated with a special grease (Grease, SYN-TECH, HMS 20-1155, NS 4405 FG).

    a. When cool, the grease has a very thick consistency but when warmed up turns into a thick liquid.

    b. Input and output seals prevent loss of grease when it has changed to a liquid.

    c. Since metal particles do not flow or move about readily in this grease, a chip detector cannot be used to detect metal particles in the grease.

    d. Grease level should be checked after run-up when the grease is warm.

    e. The grease aids in TRGB cooling by transferring heat from hot inner components to the outer housing assembly where dissipation occurs.

2. The grease provides lubrication during normal operation, after a rotating gear seal failure, or after a ballistic impact.

3. Three pounds of grease are packed into the duplex and roller bearing race pockets and into the gear mesh and adjacent cavities.

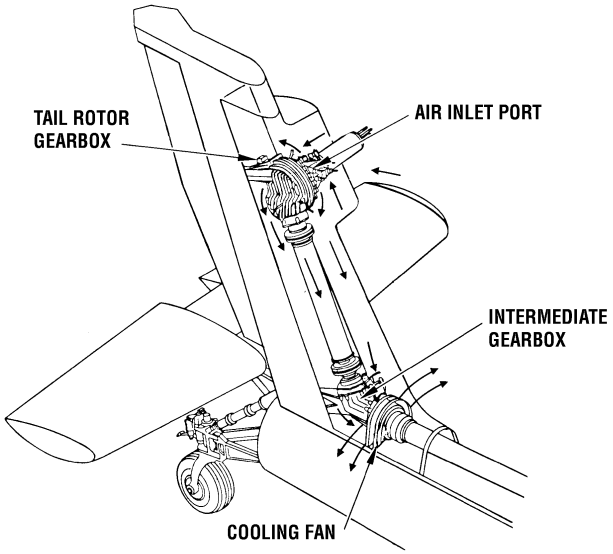
4. Five ounces of grease are packed into the output shaft roller bearings race pockets and into the cavities between the bearings.

5. Twelve ounces of grease are packed into the quill shaft cavity.

6. Seals and shields retain the grease around the bearings and gears.

7. Servicing with special grease is accomplished through a service plug on the lower right of the housing assembly.

TAIL ROTOR GEARBOX ASSEMBLY COOLING



06-93-70
83-353B

NOTES

CAUTION

Prolonged out of ground effect hovering (20 - 30 minutes) with outside air temperatures above 75E F (24E C) may cause the tail rotor gearbox to overheat.

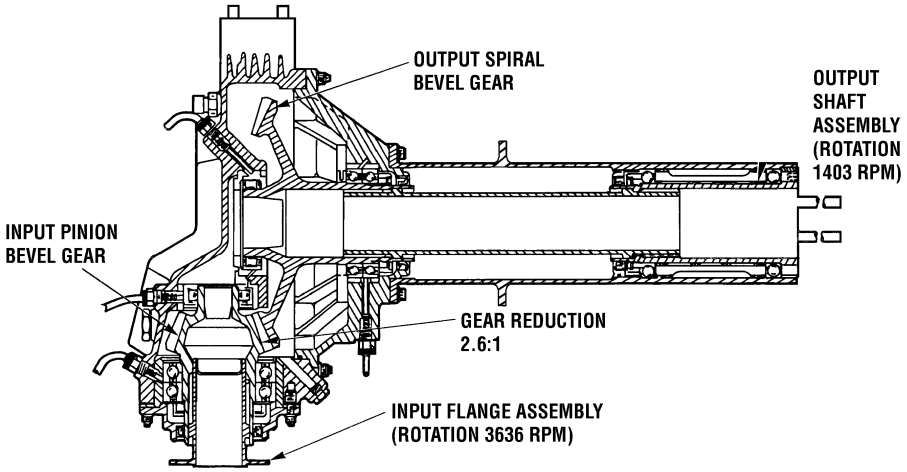
CC. TRGB cooling

1. Cooling air is provided by the ram air inlet port on the leading edge of the vertical stabilizer.

2. A description of TRGB cooling is given in the IGB cooling section of this document.

071-(

TAIL ROTOR GEARBOX ASSEMBLY FUNCTIONAL DESCRIPTION



06-93-21
83-372B

NOTES

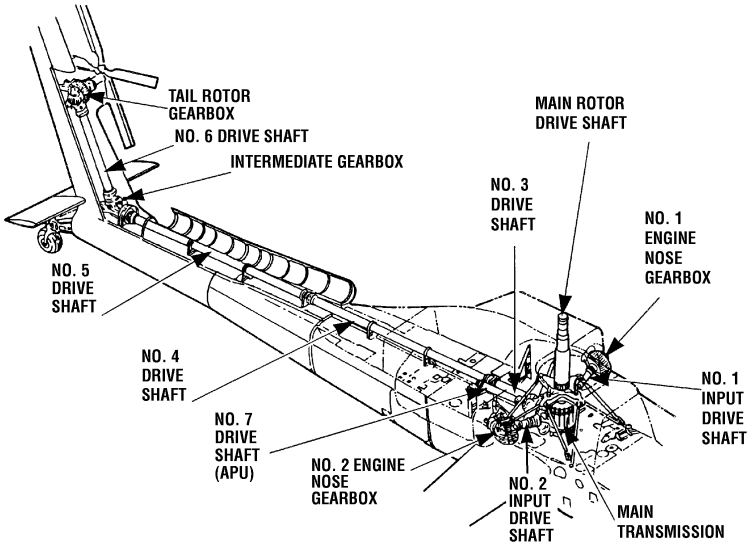
DD. TRGB operation

1. The tail rotor gearbox input flange assembly rotates at 3636 rpm.

2. A gear ratio of 2.6:1 between the input pinion bevel gear and the output spiral bevel gear reduce the speed of the output shaft to 1403 rpm.

3. Output shaft rotates clockwise.

DRIVE SHAFTS



NOTES

EE. Drive shafts

1. Transmit drive power to the helicopter drive system components.

2. Number 1 and Number 2 drive shaft assemblies are installed between the nose gearbox and the main transmission.

3. Numbers 3, 4, 5 and 6 drive shaft assemblies are located between the main transmission and tail rotor gearbox.

4. APU drive shaft (No. 7) is installed between the APU and the main transmission's accessory drive.

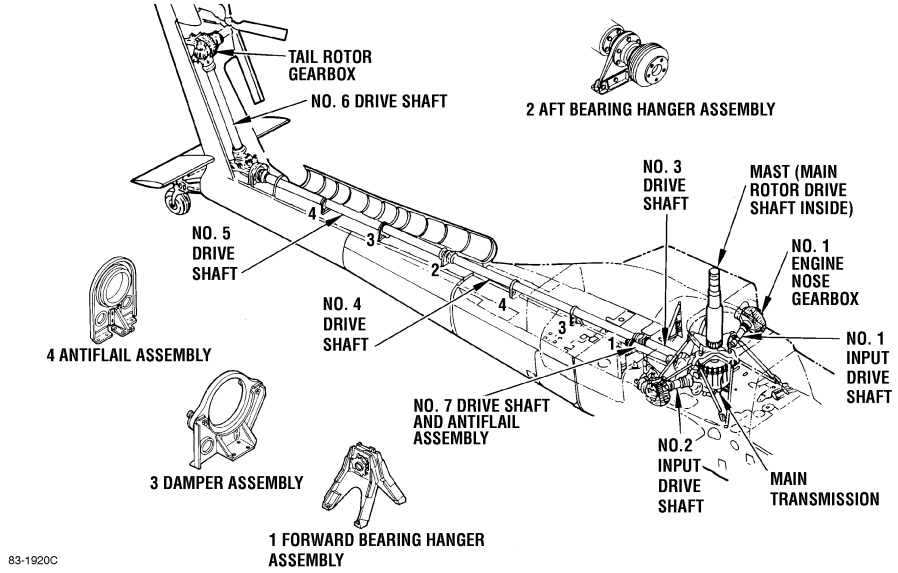
5. The main rotor drive shaft is installed inside the static mast.

6. Except for the main rotor drive shaft, no lubrication is required during installation of the drive shaft assemblies (#1 through #7).

7. No shim stock is required to install the drive shaft assemblies.

071-(

DRIVE SHAFTS - MAJOR COMPONENTS



NOTES

8. Drive shaft major components

   a. Input drive shaft assemblies (No. 1 and No. 2)

   b. Tail rotor drive shaft assemblies (No. 3, No. 4, No. 5, and No. 6)

   c. Bearing hanger assemblies

   d. Damper assemblies

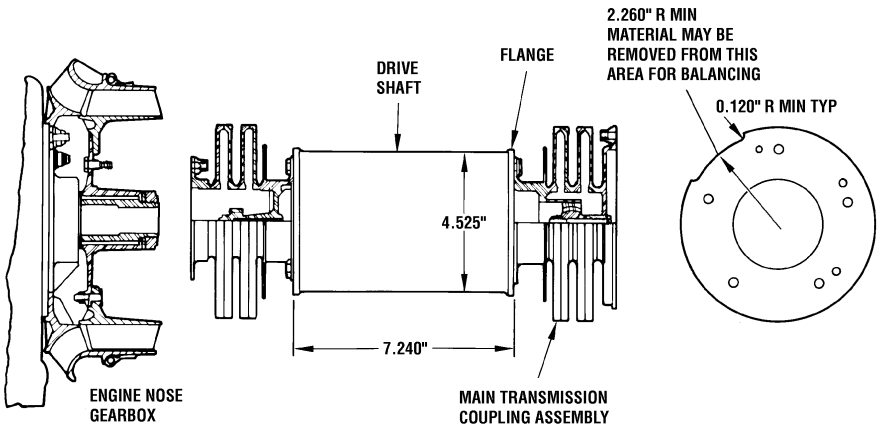
   e. Anti-flail assemblies

   f. APU drive shaft (No. 7)

   g. APU anti-flail assembly

   h. Main rotor drive shaft

INPUT DRIVE SHAFT (NO. 1 AND NO. 2)



NOTES

FF. Component description

1. Input drive shafts (No. 1 and No. 2)

a. Transmit power from the nose gearboxes to the main transmission.

b. Number 1 drive shaft is on the left and number 2 is on the right.

c. Components

(1) Input drive shaft assemblies (No. 1 and No. 2).

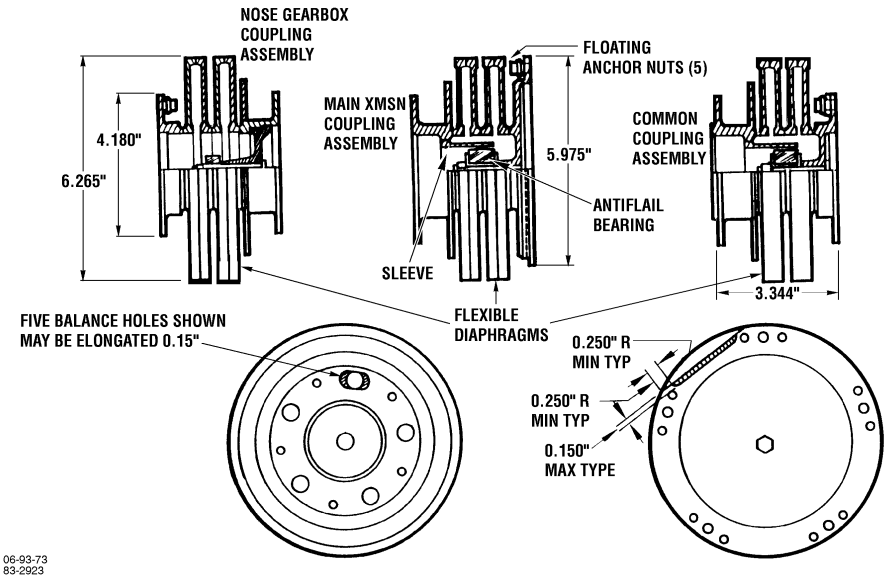
(2) Engine nose gearbox and main transmission coupling.

d. Component description

(1) The large diameter hollow aluminum input drive shafts are interchangeable.

(2) The shafts are integrally flanged at each end.

COUPLING ASSEMBLIES



NOTES

2. Coupling assemblies

   a. Flexible coupling assemblies are large dual diaphragm types made of titanium.

   b. Diaphragms and flanges are a six piece bonded construction.

   c. One flange contains five floating anchor nuts.

   d. Opposite flange has five attaching bolt holes.

   e. Bolts used to attach the drive shafts to their respective flanges are specially modified NAS 6704U4 bolts. Each of these bolts has been reworked to obtain a weight of 6.05 to 6.25 grams. These are the only bolts (P/N 7-113500019) that can be used when replacing worn or damaged bolts.

   f. Each flexible coupling assembly incorporates an anti-flail bearing.

      (1) The anti-flail bearing is mounted to one flange, centered and held by a bolt and nut combination.

      (2) The opposite flange contains a sleeve that extends over the bearing outer race. (Nose gearbox coupling assembly does not have the sleeve.)

      (3) The anti-flail bearings are 15 percent graphite impregnated teflon.

      (4) The anti-flail bearings support the drive shaft sections in position if the flexible couplings fail.

   g. Balancing is accomplished by removing material from the flange 1/2-inch diameter balance holes or on the flats.

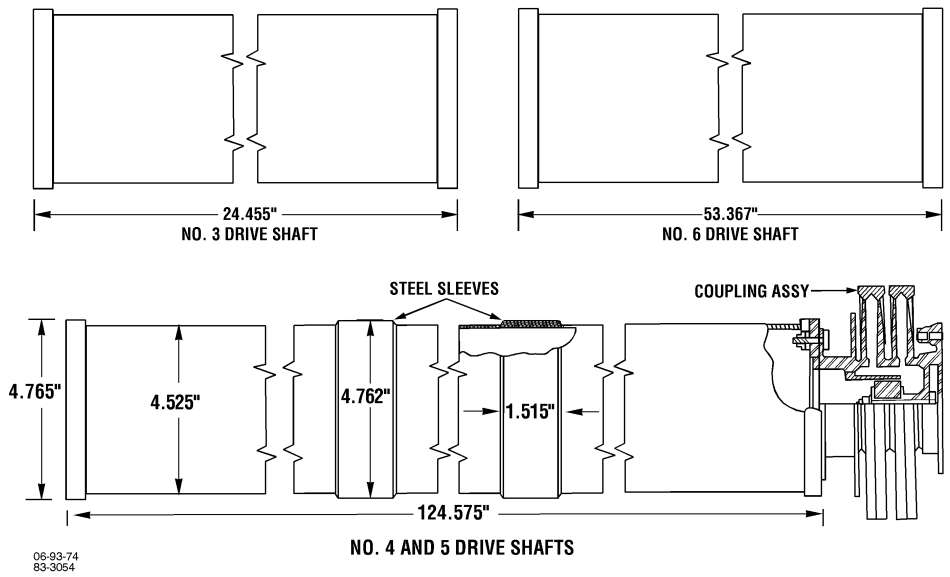
   h. Each flexible coupling assembly is identified and serialized on the diaphragm outside diameter.

   i. Input drive shaft flexible coupling assemblies are not interchangeable.

   j. Tail rotor flexible coupling assemblies (6 ea) are interchangeable with each other.

071-(

TAIL ROTOR DRIVE SHAFTS



NOTES

3. Tail rotor drive shaft assemblies (No. 3, No. 4, No. 5 and No. 6)

   a. To transmit power from the main transmission to drive the tail rotor.

   b. The drive shafts are connected by couplings to the main transmission, hanger assemblies and gearboxes.

   c. The drive shafts are large tubular shafts made of aluminum alloy.

   d. The No. 3 drive shaft is a short section which connects to the main transmission and forward hanger assembly.

   e. The No. 4 and No. 5 drive shafts are separated by the aft hanger assembly and are interchangeable.

      (1) Two steel sleeves are bonded at each of the drive shafts.

      (2) The forward sleeve is used in conjunction with the damper assembly.

      (3) The aft sleeve is used in conjunction with the anti-flail assembly.

   f. The longest shafts in the system have no bearing supports except at the ends.

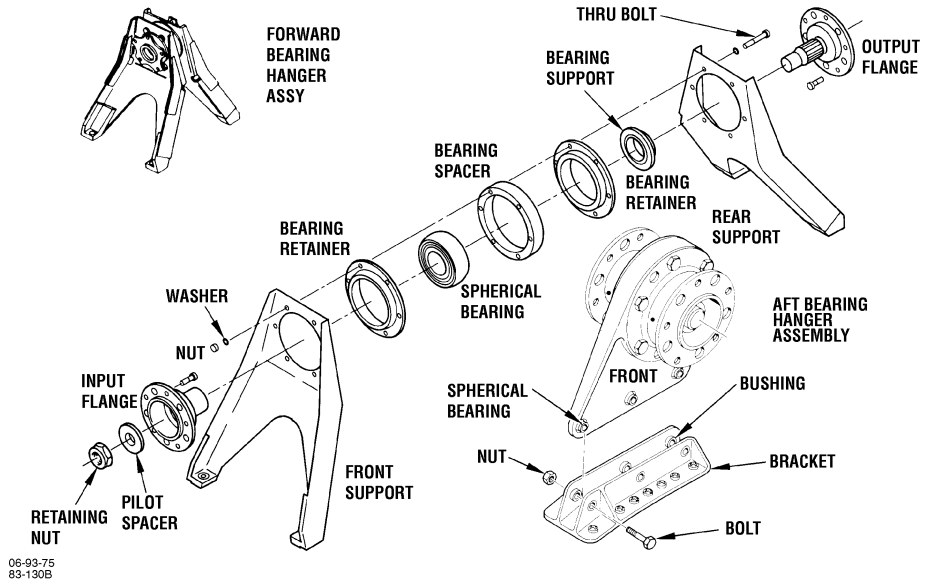
   g. No. 4 and No. 5 are "super-critical" drive shafts. The term "super-critical" means that the shaft rotates at a higher than critical speed.

      (1) Every shaft, depending on length and stiffness, has a critical speed at which point the shaft can self-excite in deflection to destruction.

      (2) This shaft is nursed through critical speeds by two shaft dampers which dampen out self-excitation.

   h. The short No. 6 drive shaft is connected between the intermediate gearbox and the tail rotor gearbox.

BEARING HANGER ASSEMBLIES



NOTES

4. Bearing hanger assemblies

   a. Provide connection, support, and alignment for the No. 3, No. 4 and No. 5 drive shafts.

   b. Forward bearing hanger

      (1) The forward bearing hanger assembly is a rigid "A" frame and consists of:

         (a) A flanged bearing assembly.

         (b) Two rigid "A"-Frame aluminum alloy supports mounted directly to the tail boom upper surface.

      (2) The flanged bearing assembly is mounted between the two rigid A-frame supports.

      (3) The flanged bearing assembly is a sealed, self-aligning bearing made up of:

         (a) Two bearing retainers.

         (b) A spherical bearing.

         (c) A bearing spacer.

         (d) A bearing support.

      (4) The bearing is free to move when subjected to oscillatory torque loads.

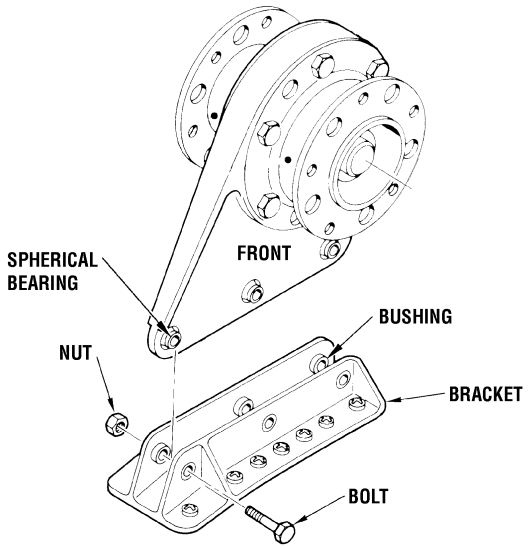
      (5) Bearing internal clearance allows "3/4 degree misalignment.

         (a) Torque loads vary due to RPM, required tail rotor thrust, aerodynamic factors, etc.

         (b) As torque loading varies, the drive shafts twist and flex. The bearings permit drive shaft misalignment as a result of the twisting and flexing.

      (6) The rigid support provides positive center line alignment.

AFT BEARING HANGER ASSEMBLY



NOTES

c. Aft bearing hanger

(1) The aft bearing hanger assembly is a semirigid assembly and consists of:

(a) A flanged bearing assembly identical to the forward bearing assembly.

(b) A single semirigid aluminum alloy support mounted to a bracket assembly.

(2) The semirigid support incorporates three spherical bearings which allow:

(a) Positive center line alignment.

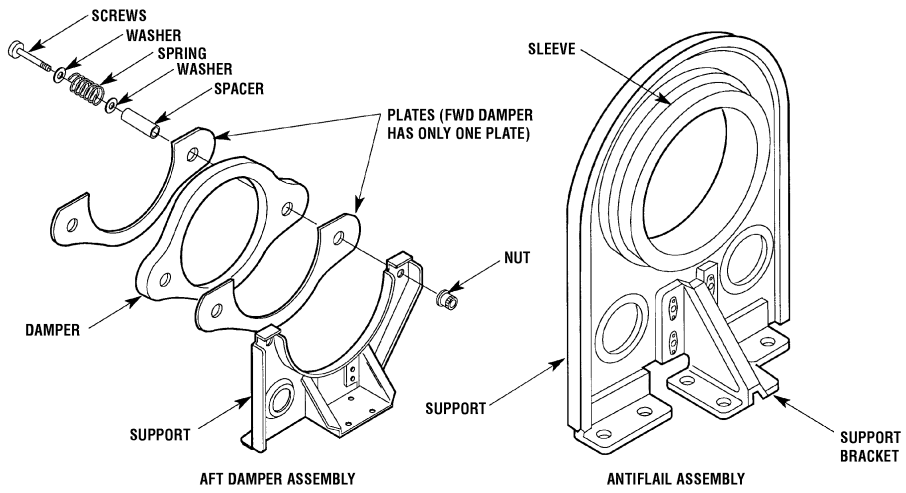
(b) The support to swing fore and aft for axial alignment.

(3) The Fwd and Aft bearing hanger assemblies incorporate a 1/8-inch (.317 cm) deep pilot in the mating flanges for a positive alignment of the drive shaft sections.

(4) Balancing is accomplished by removing material from the flange 1/2-inch (1.27 cm) diameter balance holes. The five (5) 1/2-inch (1.27 cm) diameter holes in each flange may be elongated to 0.15 inch (0.38 cm) maximum per side for balancing.

(5) Each bearing hanger assembly is identified and serialized on the top surface.

DRIVE SHAFT DAMPER AND ANTIFLAIL ASSEMBLIES



NOTES

5. Damper assemblies

   a. Detune the natural frequencies of the drive shaft and allow them to rotate through critical speeds.

   b. The damper assemblies encircle the forward steel sleeves on the No. 4 and No. 5 drive shafts and are mounted to the upper surface of the tail boom.

   c. The damper assemblies consist of:

      (1) An aluminum alloy support.

      (2) A graphite impregnated teflon floating damper.

      (3) An adjustable aluminum alloy backup plate (one plate on the forward damper; two plates on the aft damper).

   d. The forward and aft damper support brackets are mounted to the tail boom's upper surfaces.

   e. The graphite in the floating ring provides a slippery surface for rotation of the drive shaft steel sleeves.

   f. The floating damper is controlled by adjusting the tension on the backup plate(s) (adding or removing washers). Breakaway tension is 9 to 11 pounds.

6. Antiflail assemblies

   a. The anti-flail assemblies hold the No. 4 and No. 5 drive shafts in position if partial or full separation or severance of the drive shaft occurs.

   b. The forward and aft anti-flail support brackets are mounted to the tail boom upper surface.

   c. The anti-flail assemblies consist of:

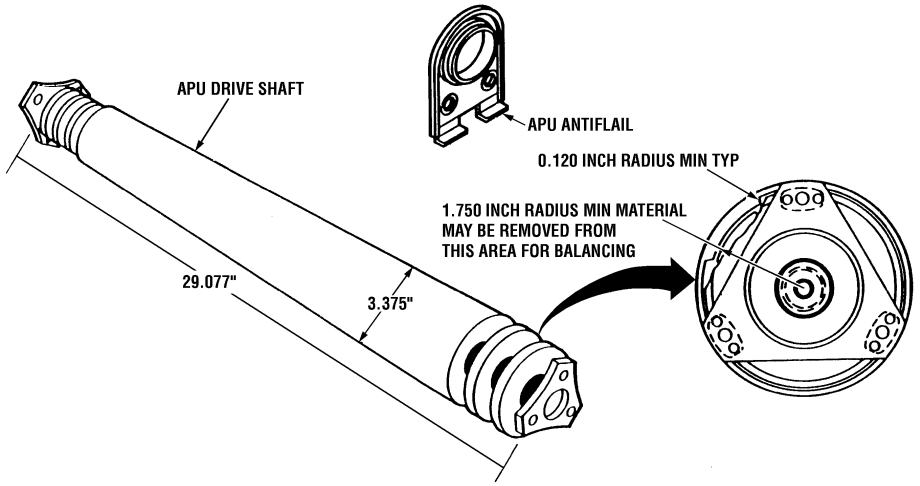
      (1) An aluminum alloy support.

      (2) A graphite impregnated teflon sleeve.

   d. The graphite in the teflon sleeve provides a slippery surface for rotation of the drive shaft steel sleeves.

071-(

APU DRIVE SHAFT



NOTES

7. APU drive shaft (No. 7)

   a. Transmits power from the APU to drive the main transmission accessory drive train.

   b. The APU drive shaft is installed between the APU P.T.O. clutch and the main transmission accessory input flange.

   c. The APU drive shaft is a large thin-wall tubular shaft made of titanium alloy.

   d. Two large dual diaphragm-type flexible coupling assemblies are integral to the APU drive shaft. The flexible coupling assemblies are identical and perform the same function as the input drive shaft coupling assemblies.

   e. The APU drive shaft is identified and serialized on the inboard coupling flange.

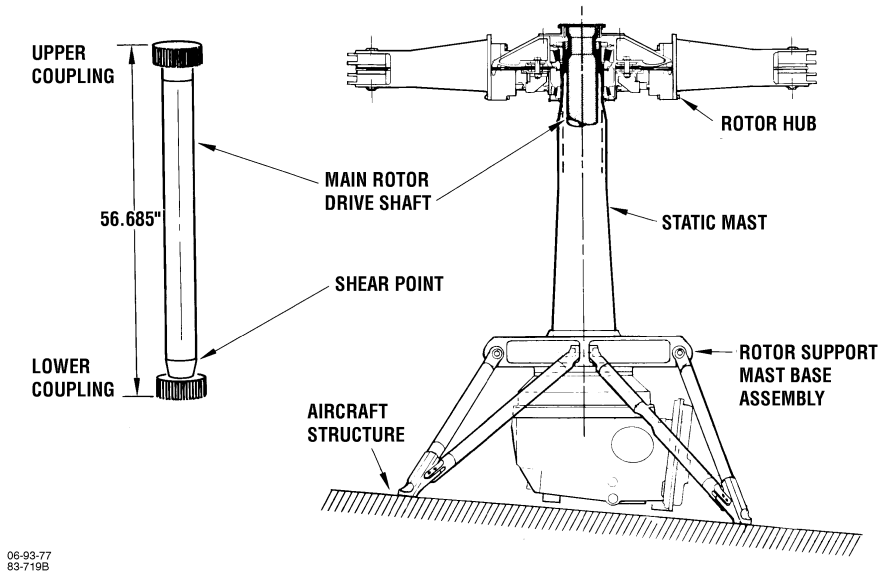
8. APU anti-flail assembly

   a. Prevents loss of the APU drive shaft in the event of partial or complete drive shaft or coupling assembly failure.

   b. Encircles the aft flexible coupling area of the APU drive shaft and is mounted at Station 247.710.

   c. The anti-flail assembly is a one piece aluminum-bronze plasma-coated (inside surface only) aluminum alloy support.

MAIN ROTOR DRIVE SHAFT



NOTES

9. Main rotor drive shaft

   a. Transmits power from the main transmission to drive the main rotor head.

   b. Located inside the static mast between the main transmission splined output carrier hub and the splined drive plate of the main rotor head.

   c. Features and capabilities

      (1) Semi-floating drive shaft

      (2) Accepts a torsional load only

      (3) Designed to shear in the event of a gear train seizure

   d. The main rotor drive shaft is a large tubular shaft with integral external splined couplings at each end.

   e. The drive shaft is constructed of a three-piece weldment that consists of:

      (1) Upper and lower couplings that are made from a steel forging.

      (2) A tube section that is made of maraging steel (low carbon with 25% nickel).

   f. Drive shaft dimensions

      (1) Inside diameter - 4.400 inches (11.8 cm)

      (2) Outside diameter - 5.060 inches (12.9 cm)

      (3) Length - 56.685 inches (143.97 cm)

      (4) Upper spline pitch diameter - 6.857 inches (17.42 cm)

      (5) Lower spline pitch diameter - 5.142 inches (13.06 cm)

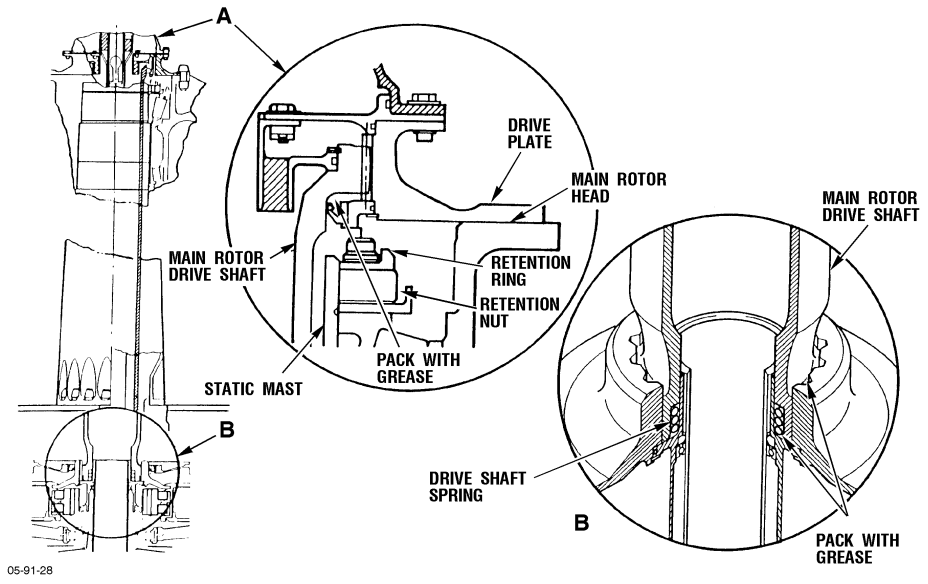
      (6) Lower coupling neck (shear point)

         (a) Inside diameter - 3.625 inches (9.20 cm)

         (b) Outside diameter - 5.125 inches (13.01 cm)

071-(

MAIN ROTOR DRIVE SHAFT- DESCRIPTION



NOTES

g. Main rotor drive shaft - description

(1) The upper splined coupling provides:

(a) An external machined journal just below the spline to seal the lower spline area of the drive plate.

(b) A machined internal surface to accept the semi-flexible support assembly.

(2) The lower splined coupling provides:

(a) A shear point in the event of a drive-train seizure.

(b) A machined area on the inside diameter to accept the drive shaft spring.

1) The spring supports 150 pounds "10.0 pounds (68 "4.54 kilograms) when compressed to 1.30 inches (3.30 cm) in length.

2) Supports the drive shaft within the carrier hub of the main transmission.

3) Spring dimensions

a) Wire diameter - 0.250 inch (.63 cm)

b) Outside diameter - 4.120 inches (10.46 cm)

c) Free length - 4.82 inches (12.24 cm)

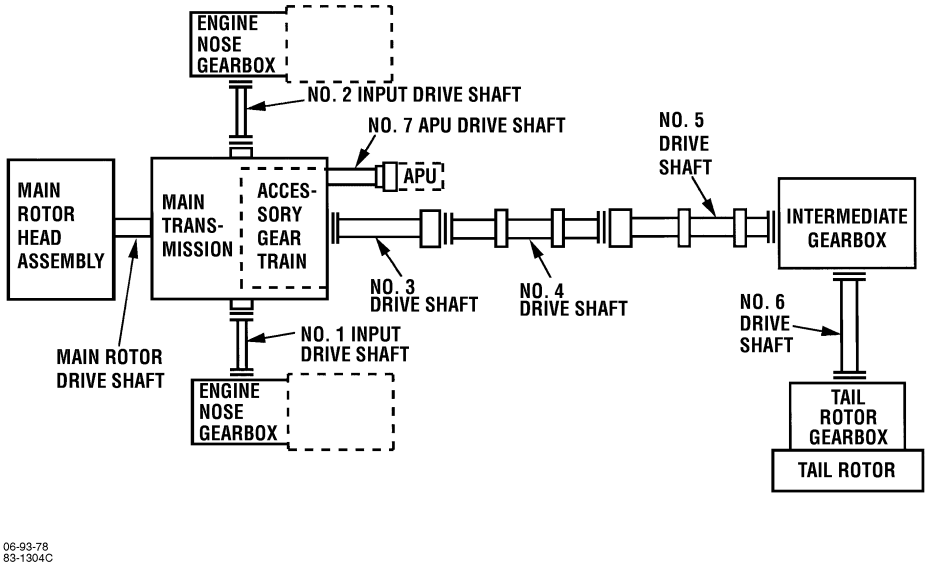
h. Lubrication

(1) Syntech 3913-G Grease

(2) Pack cavity area of bearing carrier housing and drive plate with grease.

071-(

DRIVE SHAFTS
FUNCTIONAL DESCRIPTION



NOTES

GG. Drive shaft operation

1. The input drive shafts (No. 1 and No. 2) transmit power from the engine nose gearbox to drive the main transmission.

2. As the main rotor drive shaft is turned, the driving torque received from the main transmission is transmitted to the main rotor drive plate.

3. The drive plate is bolted to the main rotor head assembly and rotates the main rotor head around the static mast through a pair of tapered roller bearings at 289 rpm (100 percent N_R).

4. Power from the main transmission turns drive shaft sections No. 3, 4, 5, and 6 to drive the intermediate and tail rotor gearboxes.

5. The hanger assemblies support and allow the drive shaft sections to rotate.

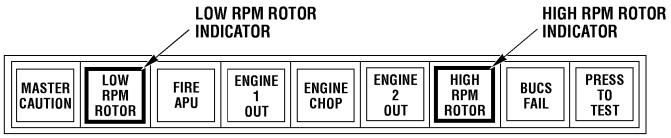
6. The damper assemblies dampen the drive shaft natural frequencies and permit it to rotate through critical speeds.

7. Graphite in the floating ring provides a slippery surface for rotation of the drive shaft steel sleeves.

8. With the main rotor disengaged or operating at speeds lower than 95% N_R, the APU drive shaft (No. 7) transmits the power from the APU to drive the main transmission accessory gear train.

071-6

MASTER CAUTION/WARNING PANEL



06-94-24

NOTES

HH. Cockpit indicators

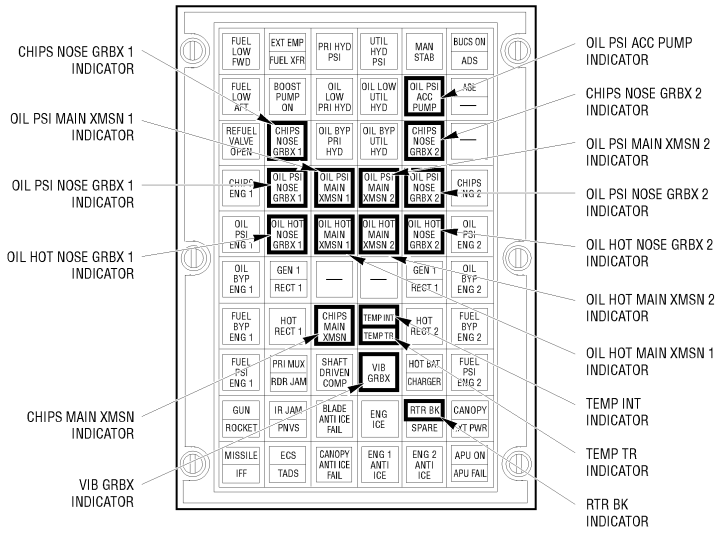
1. The powertrain system is monitored by various indicators in both the pilot and CPG stations.

2. The master caution warning panels, pilot's caution/warning/advisory (C/W/A) panel, and CPG's C/W/A panel provide indications of powertrain system malfunctions.

II. Master caution warning panels

Pilot and CPG Master Caution/Warning Panels		
Word Segment	**Color**	**Illumination Parameter or Fault**
LOW RPM ROTOR	RED	Indicates that N_R is less than 94%. The LOW RPM ROTOR light is activated by a signal from the engine out warning unit (EOW). The N_R magnetic pickup supplies the EOW with main rotor (N_R) speed signals. When activated, the light illuminates in the steady-on state and is accompanied by an audible tone in the intercommunications system (ICS). The audible tone is reset by pressing either ENGINE OUT warning switch-light.
HIGH RPM ROTOR	RED	Indicates that N_R is more than: 104% (-701 engine). 108% (-701C engine). The HIGH RPM ROTOR light is activated by a signal from the engine out warning unit (EOW). The N_R magnetic pickup supplies the EOW with main rotor (N_R) speed signals. When activated, the light illuminates in the steady-on state and remains illuminated as long as N_R is above the specified value. The light is not be accompanied by an audible tone.

PILOT CAUTION/WARNING PANEL

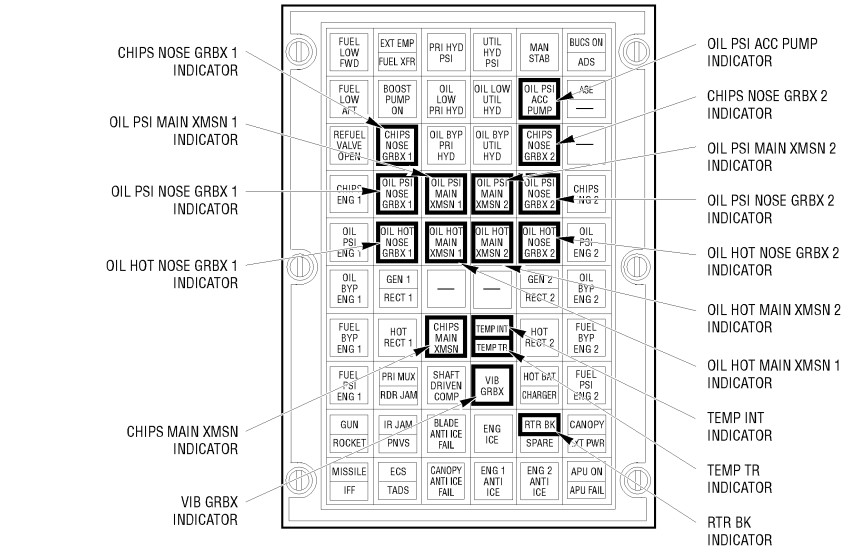


NOTES

JJ. Caution/warning/advisory panels

Pilot Caution/Warning/Advisory Panel		
Word Segment	**Color**	**Illumination Parameter or Fault**
OIL PSI ACC PUMP	AMBER	Indicates that the main transmission accessory gearbox oil pressure is below 26 - 30 PSI. Illuminates at 26 - 30 PSI decreasing; extinguishes at 45 PSI increasing. A pressure switch, mounted on the accessory oil fitter assembly, monitors the accessory oil system pressure during gear train operations. When low pressure conditions are sensed, the switch closes and a path to ground is completed, causing the caution light to illuminate.
CHIPS NOSE GRBX 1	AMBER	Indicates that the No. 1 engine nose gearbox oil contains metal fragments. The NGB chip detector/temperature switch senses the presence of metal chips in the oil, burns off small metal particles, and monitors the oil temperature. When large metal particles in the NGB oil (chips which capacitor discharge cannot burn off) collect on the chip detector, a path to ground is completed, causing the caution light to illuminate.
CHIPS NOSE GRBX 2	AMBER	Indicates that the No. 2 engine nose gearbox oil contains metal fragments. The NGB chip detector/temperature switch senses the presence of metal chips in the oil, burns off small metal particles, and monitors the oil temperature. When large metal particles in the NGB oil (chips which capacitor discharge cannot burn off) collect on the chip detector, a path to ground is completed, causing the caution light to illuminate.

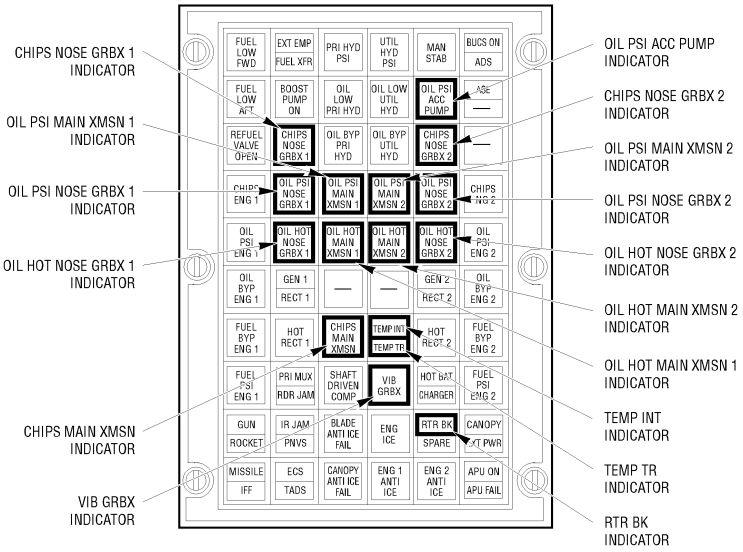
PILOT CAUTION/WARNING PANEL



NOTES

OIL PSI NOSE GRBX 1	AMBER	Indicates that the No. 1 engine nose gearbox oil pressure is below 26 - 30 PSI. Illuminates at 26 - 30 PSI decreasing; extinguishes at 45 PSI increasing. An oil pressure switch, mounted on the center front of the NGB housing, monitors the NGB's oil pressure. When low pressure conditions are sensed, the switch closes and a path to ground is completed, causing the caution light to illuminate.
OIL PSI MAIN XMSN 1	AMBER	Indicates that the main transmission No. 1 oil system pressure is below 26 - 30 PSI. Illuminates at 26 - 30 PSI decreasing; extinguishes at 45 PSI increasing. An oil pressure switch, mounted on the output "T" fitting on the lower side of the oil sump, monitors the subsystem's oil pressure. When low pressure conditions are sensed, the switch closes and a path to ground is completed, causing the caution light to illuminate.
OIL PSI MAIN XMSN 2	AMBER	Indicates that the main transmission No. 2 oil system pressure is below 26 - 30 PSI. Illuminates at 26 - 30 PSI decreasing; extinguishes at 45 PSI increasing. An oil pressure switch, mounted on the output "T" fitting on the lower side of the oil sump, monitors the subsystem's oil pressure. When low pressure conditions are sensed, the switch closes and a path to ground is completed, causing the caution light to illuminate.
OIL PSI NOSE GRBX 2	AMBER	Indicates that the No. 2 engine nose gearbox oil pressure is below 26 - 30 PSI. Illuminates at 26 - 30 PSI decreasing; extinguishes at 45 PSI increasing. An oil pressure switch, mounted on the center front of the NGB housing, monitors the NGB's oil pressure. When low pressure conditions are sensed, the switch closes and a path to ground is completed, causing the caution light to illuminate.

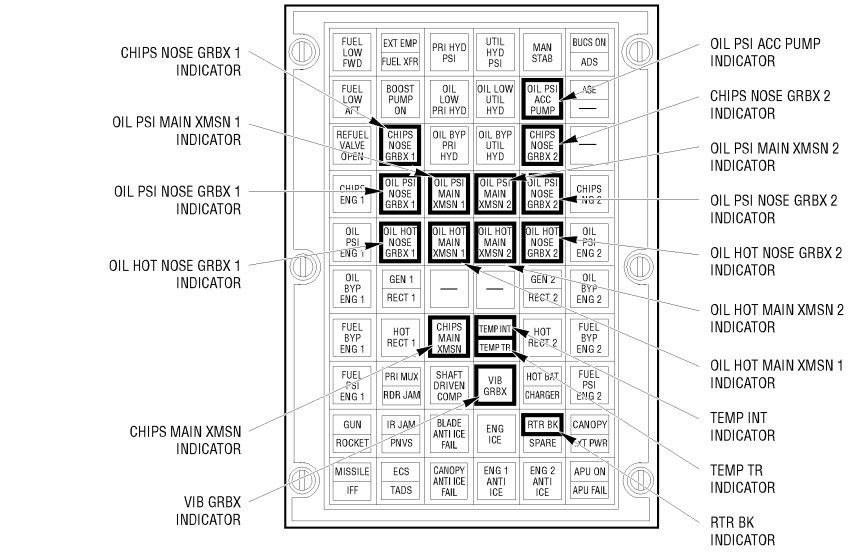
PILOT CAUTION/WARNING PANEL



NOTES

OIL HOT NOSE GRBX 1	AMBER	Indicates that the No. 1 engine nose gearbox oil temperature is above 274E - 294E F (135E - 145E C). The NGB chip detector/temperature switch, installed on the forward lower center of the oil sump, monitors the NGB oil temperature. When oil temperature exceeds 274E - 294E F (135E - 145E C), the switch closes and a path to ground is completed, causing the caution light to illuminate.
OIL HOT MAIN XMSN 1	AMBER	Indicates that the main transmission No. 1 oil system temperature is above 274E - 294E F (135E - 145E C). The main transmission chip detector/temperature switch, installed on the side of the lower main transmission housing below the oil level sight plug, monitors the subsystems oil temperature. When oil temperature exceeds 274E - 294E F (135E - 145E C), the switch closes and a path to ground is completed, causing the caution light to illuminate.
OIL HOT MAIN XMSN 2	AMBER	Indicates that the main transmission No. 2 oil system temperature is above 274E - 294E F (135E - 145E C). The main transmission chip detector/temperature switch, installed on the side of the lower main transmission housing below the oil level sight plug, monitors the subsystems oil temperature. When oil temperature exceeds 274E - 294E F (135E - 145E C), the switch closes and a path to ground is completed, causing the caution light to illuminate.
OIL HOT NOSE GRBX 2	AMBER	Indicates that the No. 2 engine nose gearbox oil temperature is above 274E - 294E F (135E - 145E C). The NGB chip detector/temperature switch, installed on the forward lower center of the oil sump, monitors the NGB oil temperature. When oil temperature exceeds 274E - 294E F (135E - 145E C), the switch closes and a path to ground is completed, causing the caution light to illuminate.
CHIPS MAIN XMSN	AMBER	Indicates that the main transmission chip detector has detected metal fragments. The main transmission chip detector/temperature switches sense the presence of metal chips in the oil, burn off small metal particles, and monitors the oil temperature. When large metal particles in either main transmission oil system (chips which capacitor discharge cannot burn off) collect on either chip detector, a path to ground is completed, causing the caution light to illuminate.

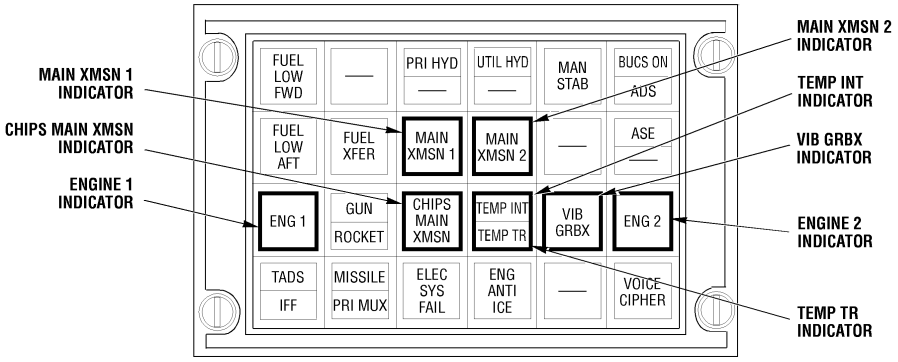
PILOT CAUTION/WARNING PANEL



NOTES

TEMP INT	AMBER	Indicates that the intermediate gearbox temperature is above 274E - 294E F (135E - 145E C). Four spring-loaded thermistors, installed in the intermediate gearbox, maintain constant contact with the bearing housings. When a temperature above 274E - 294E F (135E - 145E C) occurs, the thermistors send a signal to the IGB temperature alarm unit located behind the intermediate gearbox. The IGB temperature alarm unit provides a ground for the caution light causing it to illuminate.
TEMP TR	AMBER	Indicates that the tail rotor gearbox temperature is above 274E - 294E F (135E - 145E C). Four spring-loaded thermistors, installed in the tail rotor gearbox, maintain constant contact with the bearing housings. When a temperature above 274E - 294E F (135E - 145E C) occurs, the thermistors send a signal to the TRGB temperature alarm unit located behind the intermediate gearbox. The TRGB temperature alarm unit provides a ground for the caution light causing it to illuminate.
VIB GRBX	AMBER	Indicates that the intermediate or tail rotor gearbox vibration level is excessive. Each gearbox is provided with an accelerometer which is used for rotor tracking and active gearbox vibration level monitoring. Each gearbox accelerometer sends a signal to the rotor balance signal processor located in the CPG's compartment. The signal is processed by the rotor signal processor. When an excessive vibration is picked up by the accelerometer, the processor provides a ground that causes the VIB GRBX segment lights in the pilot and CPG stations to illuminate.
RTR BK	AMBER	Indicates that the rotor brake switch is in the BRAKE/LOCK position. When the rotor brake pressure switch is closed (hydraulic pressure is sensed in rotor brake hydraulic circuit), 28 VDC is applied to the RTR BK caution light, causing it to illuminate.

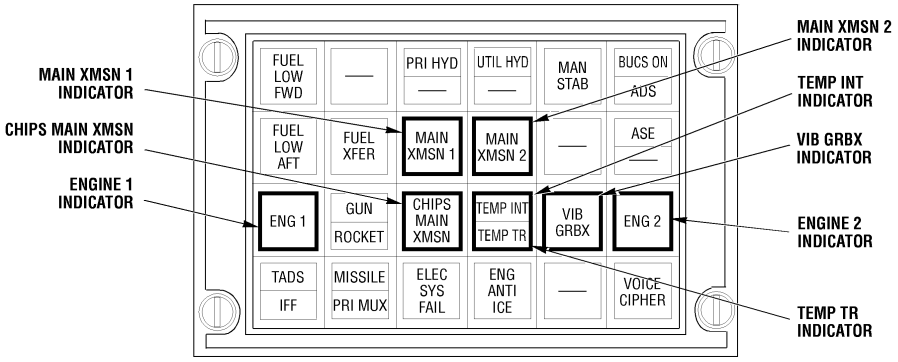
CPG CAUTION/WARNING PANEL



NOTES

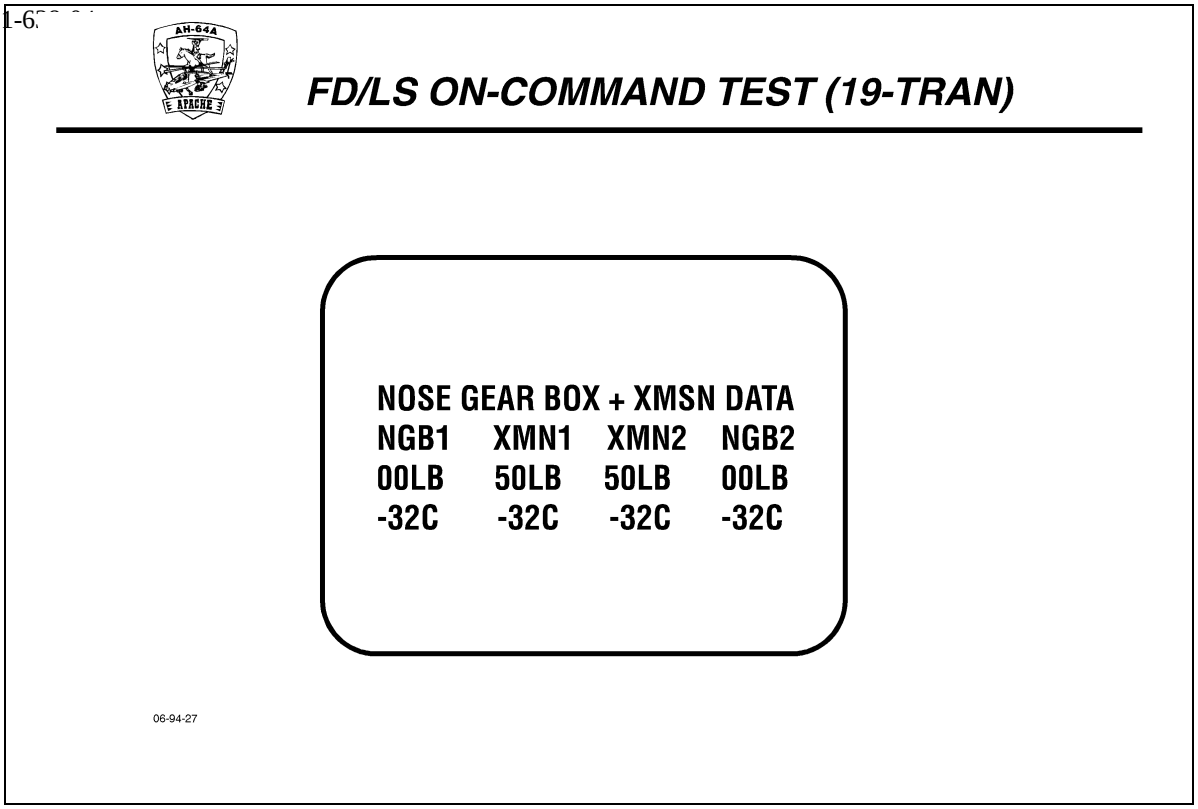
CPG Caution/Warning/Advisory Panel		
Word Segment	**Color**	**Illumination Parameter or Fault**
MAIN XMSN 1	AMBER	Indicates that one or a combination of the following conditions exist: main transmission oil temperature high, oil pressure low. The pilot's caution/warning/advisory panel provides the fault input signal (ground) to the CPG's caution light, causing it to illuminate.
MAIN XMSN 2	AMBER	Indicates that one or a combination of the following conditions exist: main transmission oil temperature high, oil pressure low. The pilot's caution/warning/advisory panel provides the fault input signal (ground) to the CPG's caution light, causing it to illuminate.
ENG 1	AMBER	Indicates that one or a combination of the following conditions exist: engine oil pressure low, engine oil filter in bypass, engine chips, engine fuel filter in bypass, engine fuel pressure low, **nose gearbox chips, nose gearbox oil pressure low, nose gearbox oil temperature high.** The pilot's caution/warning/advisory panel provides the fault input signal (ground) to the CPG's caution light, causing it to illuminate.
CHIPS MAIN XMSN	AMBER	Indicates that one or both of the main transmission chip detectors has detected metal fragments. The pilot's caution/warning/advisory panel provides the fault input signal (ground) to the CPG's caution light, causing it to illuminate.
TEMP INT	AMBER	Indicates that the intermediate gearbox temperature is above 274E - 294E F (135E - 145E C). The pilot's caution/warning/advisory panel provides the fault input signal (ground) to the CPG's caution light, causing it to illuminate.
TEMP TR	AMBER	Indicates that the tail rotor gearbox temperature is above 274E - 294E F (135E - 145E C). The pilot's caution light triggers the CPG's caution light.
VIB GRBX	AMBER	Indicates that the intermediate or tail rotor gearbox vibration level is excessive. The pilot's caution/warning/advisory panel provides the fault input signal (ground) to the CPG's caution light, causing it to illuminate.

CPG CAUTION/WARNING PANEL



NOTES

ENG 2	AMBER	Indicates that one or a combination of the following conditions exist: engine oil pressure low, engine oil filter in bypass, engine chips, engine fuel filter in bypass, engine fuel pressure low, **nose gearbox chips, nose gearbox oil pressure low, nose gearbox oil temperature high.** The pilot's caution/warning/advisory panel provides the fault input signal (ground) to the CPG's caution light, causing it to illuminate.


AH-64A
APACHE
FD/LS ON-COMMAND TEST (19-TRAN)
NOSE GEAR BOX + XMSN DATA
NGB1 XMN1 XMN2 NGB2
00LB 50LB 50LB 00LB
-32C -32C -32C -32C
06-94-27

NOTES

KK. FD/LS

1. The powertrain system transmits status information to the fire control computer (FCC) via the multiplex data (MUX) bus system. The following information is transmitted.

   a. Main transmission oil pressure

   b. Main transmission oil temperature

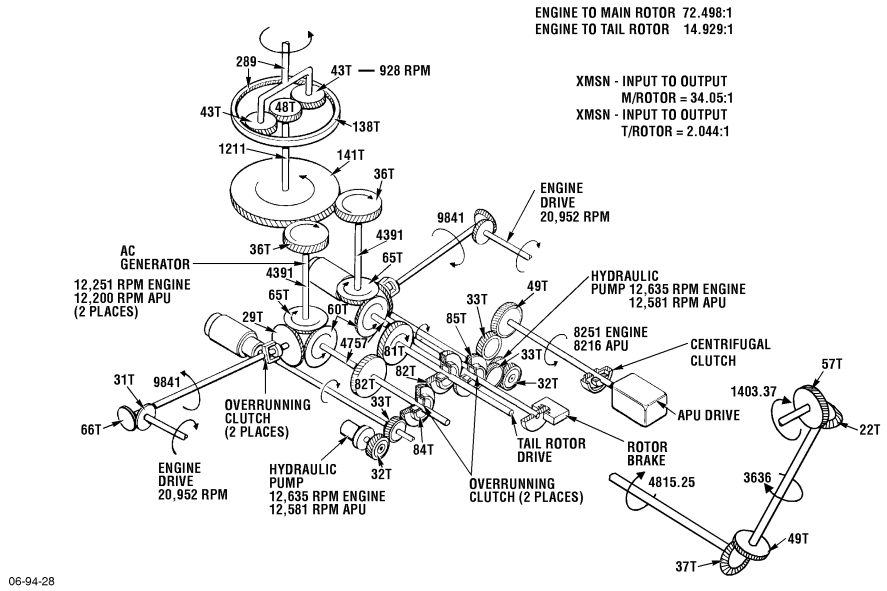
   c. NGB oil pressure

   d. NGB oil temperature

2. Integrated in the MUX bus system is the FD/LS. FD/LS utilizes the MUX bus system DEK for FD/LS command initialization and/or FCC memory read code accessing.

3. Transmission and NGB data can be accessed by initiating FD/LS on-command test "19-TRAN".

DRIVE SYSTEM SCHEMATIC



NOTES

LL. Powertrain system

1. The powertrain system transmits engine drive power from the engines to the main rotor and tail rotor assemblies. It also transmits APU drive power to the main transmission accessory gearbox when the engines are not running.

2. Drive power from engines 1 and 2 is transferred through the NGBs and input drive shafts to the main transmission.

3. The main transmission changes the angle and reduces the speed of the drive input, and transmits drive power to the main and tail rotor assemblies.

4. The drive output is transferred directly from the main transmission to the main rotor head through the main rotor drive shaft.

5. Drive output from the main transmission is transferred to the tail rotor through three drive shafts to the IGB.

6. The IGB changes the angle, reduces the speed, and applies drive power through a drive shaft to the TRGB.

7. The TRGB changes the angle, reduces the speed, and transmits drive power directly to the tail rotor head.

8. When the engines are not running, the APU transmits input power to the accessory gearbox through the APU drive shaft (No. 7) to drive the accessory section of the main transmission.

9. The accessory section can also be driven by one or both engines.

10. The accessory section drives two generators, two hydraulic pumps, and the SDC.

11. The powertrain system is designed to withstand battle damage.

    a. The powertrain can operate for 30 minutes after loss of lubrication.

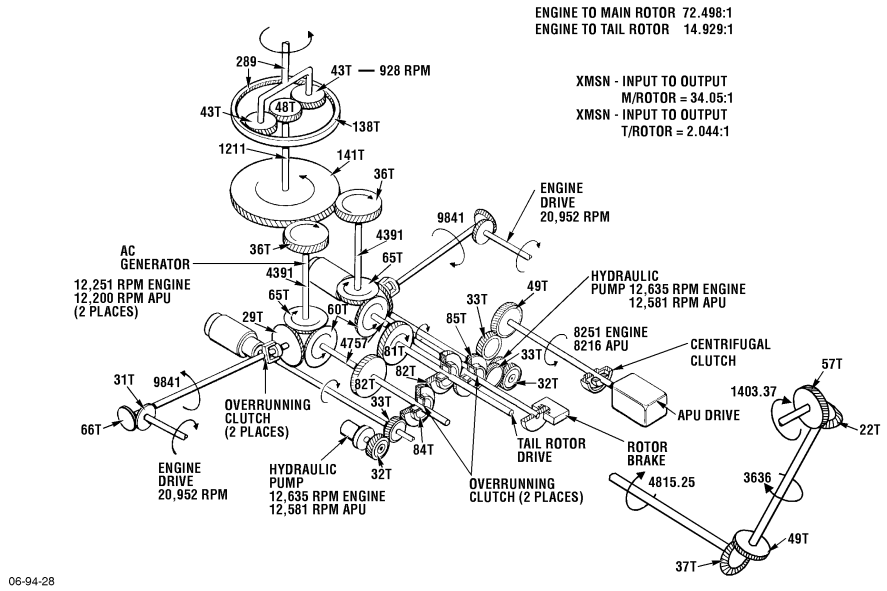
    b. The shafts are designed to prevent catastrophic failure if struck by a bullet.

    c. Specially designed anti-flail assemblies prevent drive shaft whip if a coupling were to fail.

12. The NGBs are equipped with cooling fans that draw air across the NGB cooling fins and into the transmission bay area.

13. The IGB is fitted with a fan that draws cooling air over the TRGB and IGB and then vents the air overboard.

DRIVE SYSTEM SCHEMATIC



NOTES

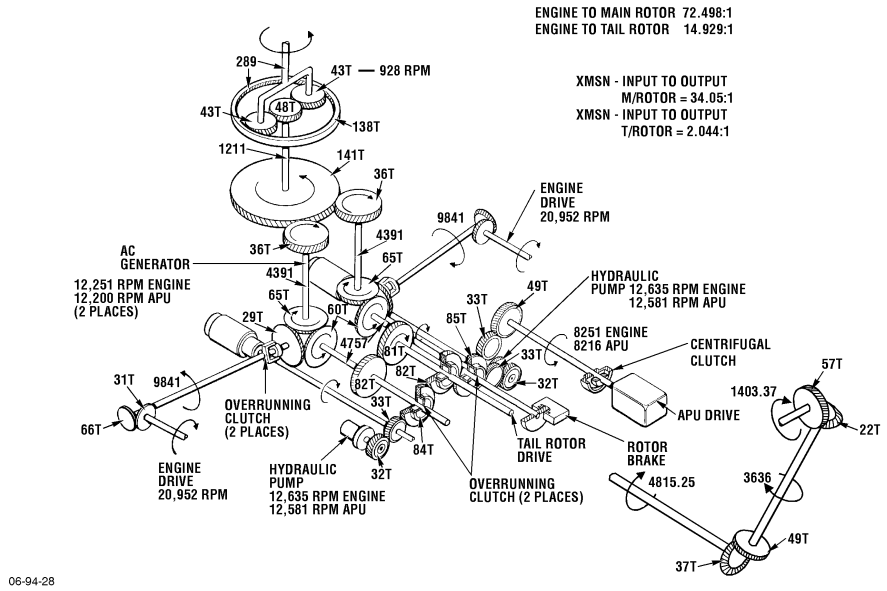
MM. Powertrain RPM data

1.	Engine output		20,952 RPM
2.	Nose gearbox		
	a.	Drive angle change	90E
	b.	Input	20,952 RPM
	c.	Output	9,841 RPM
3.	Main transmission		
	a.	Input	9,841 RPM
	b.	Output	
		(1) Main rotor	289 RPM
		(2) Tail rotor drive shaft	4,815 RPM
4.	Intermediate gearbox		
	a.	Dive angle change	71E
	b.	Input	4,815 RPM
	c.	Output	3,636 RPM
5.	Tail rotor gearbox		
	a.	Dive angle change	90E
	b.	Input	3,636 RPM
	c.	Output	1,403 RPM
6.	Accessory gearbox input (95% N_R - 100% APU speed)		8,216 RPM

NN. Powertrain system inspection

1. TM 55-1520-238-23-4 arranges drive system maintenance into sections.
   a. Section II - drive shafts
   b. Section III - main transmission
   c. Section IV - engine nose gearboxes

DRIVE SYSTEM SCHEMATIC



NOTES

d. Section V - intermediate gearbox

e. Section VI - tail rotor gearbox

2. Inspection procedures for the drive system can be found in each section.

OO. Special inspections (TM 55-1520-238-23-1)

1. Special inspection No. 11 requires NGB and main transmission oil samples be taken at 25 hours (aircraft operating time).

2. Special inspection No. 23 contains powertrain maintenance requirements after an engine over-torque.

3. Special inspection No. 24 contains powertrain maintenance requirements to be done at 50 hours (aircraft operating time).

4. Special inspection No. 26 requires NGB oil level check before first engine start of the day.

5. Special inspection No. 29 contains powertrain maintenance requirements after sudden stoppage.

6. Special inspection No. 48 contains powertrain maintenance requirements after a lightning strike.

PP. Powertrain system servicing

1. NGBs

a. Capacity - 5 pt (2.5 qt) (each gearbox)

b. Lubricating oil: MIL-L-23699 (Use in outside air temperatures of -25E F (-32E C) and above.)

MIL-L-7808 (Use in outside air temperatures of -25E F (-32E C) and below.)

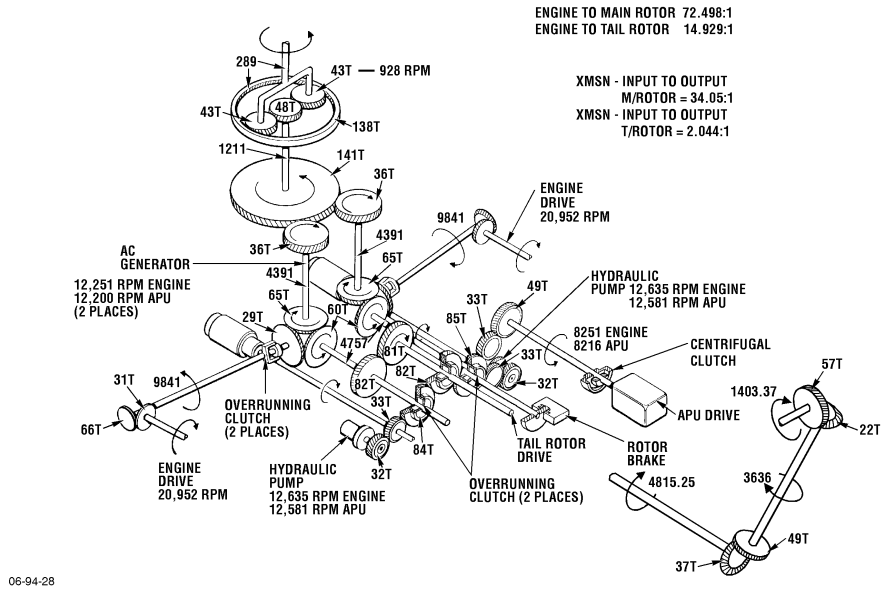
CAUTION

Do not mix oil MIL-L-23699 with oil MIL-L-7808 except in an emergency. The system must be drained and refilled with the proper oil as soon as possible if it becomes necessary to mix oils.

c. The level in the sight indicator may appear high immediately after shutdown. Wait 15 minutes after shutdown for NGB oil level to stabilize.

d. Add oil to NGB only if the level in the sight indicator is at or below the quarter level on the sight indicator (one quarter level is 0.18 inch above the bottom of the sight indicator).

DRIVE SYSTEM SCHEMATIC



NOTES

e. Four ounces of oil raises the level in the sight indicator one-quarter (0.18 inch).

f. Gearbox is full when oil level is at center of sight indicator.

2. Main transmission

a. Capacity - 45 pt (22.5 qt)

b. Lubricating oil: MIL-L-23699 (Use in outside air temperatures of -25E F (-32E C) and above.)

MIL-L-7808 (Use in outside air temperatures of -25E F (-32E C) and below.)

CAUTION

Do not mix oil MIL-L-23699 with oil MIL-L-7808 except in an emergency. The system must be drained and refilled with the proper oil as soon as possible if it becomes necessary to mix oils.

c. Helicopter must be on level surface with both main landing gear equal for proper servicing.

d. To prevent over-filling or under-filling the transmission, wait 15 minutes after rotor shutdown before checking.

e. Transmission is full when oil level is in center of both left and right sight indicators.

3. Intermediate gearbox

a. Capacity - 2 lb, 2 oz

b. Grease, SYN-Tech: HMS 20-1155
NS 4405 FG

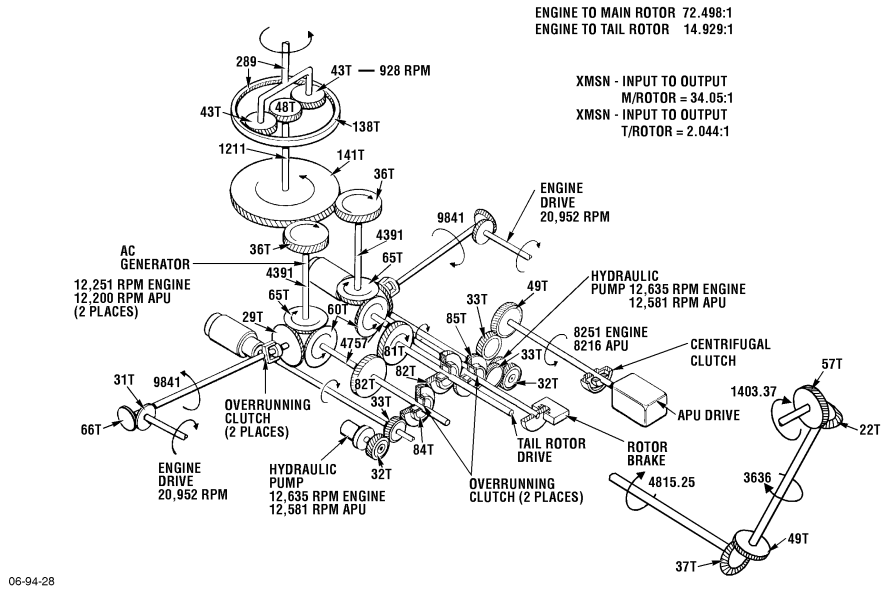
c. Helicopter must be on level surface with both main landing gear equal for proper servicing.

d. To prevent over-filling or under-filling the intermediate gearbox, wait 10 minutes after rotor shutdown before checking.

e. Grease level must be 1**2** inches below edge of filler plug hole.

f. Add grease as necessary to bring level to 1**2** inches below edge of filler plug hole. Use a grease gun.

DRIVE SYSTEM SCHEMATIC



NOTES

4. Tail rotor gearbox

   a. Capacity - 3 lb, 5 oz

   b. Grease, SYN-Tech: HMS 20-1155
      NS 4405 FG

   c. Helicopter must be on level surface with both main landing gear equal for proper servicing.

   d. To prevent over-filling or under-filling the tail rotor gearbox, wait 10 minutes after rotor shutdown before checking.

   e. Grease level must be **3** to **2** inch below edge of filler plug hole.

   f. Add grease as necessary to bring level to **3** to **2** inch below edge of filler plug hole. Use a grease gun.

QQ. Powertrain system troubleshooting

1. To perform troubleshooting on the powertrain system, refer to TM 1-1520-238-T-4.

2. For maintenance operational check procedures, refer to TM 1-1520-238-T-4.